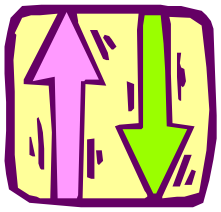
Central Coast



Volume II - ITS Project Implementation Guide

June 30th, 2000

Prepared for:

ASSOCIATION OF MONTEREY BAY AREA GOVERNMENTS (AMBAG)

SANTA CRUZ COUNTY REGIONAL TRANSPORTATION COMMISSION (SCCRTC)

COUNCIL OF SAN BENITO COUNTY GOVERNMENTS (SBCOG)

TRANSPORTATION AGENCY FOR MONTEREY COUNTY (TAMC)

SAN LUIS OBISPO COUNCIL OF GOVERNMENTS (SLOCOG)

CALIFORNIA HIGHWAY PATROL (CHP)

SANTA BARBARA COUNTY ASSOCIATION OF GOVERNMENTS (SBCAG)

SANTA BARBARA METROPOLITAN TRANSIT DISTRICT (SBMTD)

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FEDERAL TRANSIT ADMINISTRATION (FTA)

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APPENDICES

Additional materials within the Central Coast ITS Strategic Deployment Plan include the following:

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VOLUME II OVERVIEW

This portion of the Central Coast ITS Strategic Deployment Plan provides interested agencies with a set of tools to assist in the successful execution of an ITS Project. There are considerations in project definition, planning, architecture development, technology selection, purchasing, contracting, operations and maintenance, and training involved with the implementation of an ITS Project that may be new to Agency staff. Therefore, Volume II provides general guidance in these areas necessary to take ITS Projects from the Strategic Plan level to a successful deployment. The Implementation Guide also provides step-by-step instructions on how the Central Coast's Regional ITS Architecture was developed and further presents a detailed process to establish planning conformance with the Regional ITS Architecture when a new ITS Project is considered for deployment. Special treatment of all of these issues is needed, because ITS Projects are unlike many other public works type projects. Much of this information is intended for Agency staff with limited knowledge in how to carry ITS Projects forward. Many local agencies may not be directly involved in the implementation of ITS Projects for some time, and these issues may not be a concern. Other agencies may have more immediate need for this knowledge.

1. WHO IS THERE TO HELP?

1.1 CENTRAL COAST ITS COORDINATING GROUP

Although this ITS Strategic Planning project is complete, the ITS planning process is just getting under way in the Central Coast. Involved stakeholders recognize this situation and have warmly embraced the formation of an ITS Coordinating Group (as identified in Section 5.2 of Volume I – ITS Strategic Plan) to further successful ITS deployments and foster coordination across jurisdictional and agency boundaries.

It is anticipated that this group's membership would include the following organizations:

- Association of Monterey Bay Area Governments (AMBAG)
- Santa Cruz County Regional Transportation Commission (SCCRT)
- Council of Government for San Benito County (SBCOG)
- Transportation Agency of Monterey County (TAMC)
- San Luis Obispo Council of Governments (SLOCOG)
- Santa Barbara County Association of Governments (SBCAG)
- Caltrans District 5
- Caltrans New Technology and Research Program (NTRP)
- California Highway Patrol (CHP)
- Federal Highway Administration (FHWA)
- Federal Transit Administration (FTA)
- Air Quality Districts
- Local City Agencies (as ITS Projects are forwarded)

Roles/responsibilities of the group would include the following:

- Provide input on issues related to a project identified in the ITS Strategic Plan
  - Planning/programming
  - Design
  - Implementation
  - Architecture conformance
  - Funding
  - Operations and maintenance
  - Assess the status of Strategic Plan deployment
  - Work out interagency agreements/MOUs
- Coordinate Central Coast ITS initiatives with neighboring regions and statewide
- Track ITS standard-setting activities
- Update the ITS Strategic Plan

1.2 OTHER ITS RESOURCES

The Central Coast is fortunate to have a number of stakeholders well versed in ITS. This allows them to share the wealth of experience that they have accumulated over the years with all project partners. In addition, the Central Coast is not alone in its efforts to deploy ITS. Many other Agencies are planning and/or deploying ITS. The Central Coast should seek out all of these parties and use them as a resource when contemplating current and future ITS decisions. Some Agencies to consider as ITS references include:

- Federal Highway Administration (FHWA) (916) 498-5005
- Federal Transit Administration (FTA) (415) 744-3116
- California Highway Patrol (CHP) (916) 657-7222
- Caltrans New Technology and Research Program (NTRP) (916) 657-4723
- California Alliance for Advanced Transportation (CAATS) (916) 325-0474

Some Agency websites to visit to find out more information about ITS include:

- U.S. DOT (ITS Joint Program Office) http://www.its.dot.gov
- Institute of Transportation Engineers (ITE) http://www.ite.org
- ENTERPRISE http://www.enterprise.prog.org
- FHWA http://www.fhwa.dot.gov
- CHP http://www.chp.ca.gov
- ITS America http://www.itsa.org
- CAATS http://www.caats.org
- Caltrans http://www.dot.ca.gov
- FTA http://www.fta.dot.gov

1.3 KEY QUESTIONS

Oftentimes when an ITS deployment encounters an obstacle, it is of an institutional nature, not technical. Therefore, in order for the Central Coast to be more prepared for these institutional challenges, a few key questions have been prepared:

Stakeholders and Operational Objectives

1. Are all stakeholders prepared to enter into written arrangements, MOUs, charters, etc. (as necessary) to ensure project success?
2. Is a process in place to determine the project "Lead Agency"?
3. Are project roles/responsibilities consistent with the Agency's mission?
4. Are dedicated teams/staff/individuals available?
5. Do they have the appropriate knowledge, experience, and "skill set"?
6. How will you retain project "knowledge" when staff turnover occurs?
7. Is a process in place to ensure that the project's operational objectives are articulated/documented clearly, understood in the same manner by all stakeholders, and adopted into each stakeholder's mission?
8. Is a process in place to identify project issues/problems (i.e., Action Items), identify responsible parties, and target resolution dates?

Information Needs and Sharing

1. Have you examined/determined what data/information (e.g., type, format, frequency, etc.) is necessary to fulfill your Agency's mission?
2. Have you examined/determined what operations are necessary to fulfill your Agency's mission?
3. Have you reviewed your requirements in light of their impact on the overall system requirements (i.e., regional architecture) to determine if changes are warranted to make your requirements more consistent with others?
4. Is a process in place to share information and coordinate operations within/between Agencies?

Operational Implications of Information Sharing

1. Have you determined the impact that data/information sharing may have on your Agency's operations?
2. Have you determined the impact that shared operations may have on your Agency's data/information sources?

2. MOVING FROM PROJECT CONCEPT TO AN OPERATING SYSTEM

2.1 PROJECT DEFINITION

One of the main outcomes of the Central Coast ITS Strategic Deployment Plan is to successfully deploy projects. In fact, the Strategic Plan identified a number of ITS Projects for the Central Coast as indicated in Section 3.4 and Appendix E of Volume I – ITS Strategic Plan. However, it is expected that this original list of projects will be expanded or modified over time as new ideas are generated and as technology changes, offering opportunities that had not been anticipated. These additional ITS Projects or modifications need to be first defined then tied to the Central Coast Regional ITS Architecture.

To ease inclusion into future updates of the Strategic Plan, future ITS Project ideas should provide the same level-of-detail as originally presented in Appendix E (Volume I). Therefore, to assist in this process, the following instructions have been prepared to help complete the project description template:

Exhibit 2.1 - Instructions for "Filling-Out" a Project Description Form

Category	Instruction/Explanation
Project Name	A brief, descriptive name that reflects the nature of the project and its general location.
Project Description	An explanation of the elements to be included in the project and essential operational aspects, such as: the general types of technologies to be employed (categories of technology, not vendor-specific), communications systems needed for the technologies to function, information that will be gathered, how the information will be used, how various agencies will be involved in operation, etc. The description need only go so far as to describe those project elements that can be defined at this time. In some cases, further conceptual design and planning will be needed prior to

Exhibit 2.1 - Instructions for "Filling-Out" a Project Description Form

Category	Instruction/Explanation
	implementation. In other cases, the description may be a sufficient basis for preparation of design and bid documents. The description may be supplemented with diagrams, where appropriate. The description should indicate the issues that remain to be resolved, both technological and institutional.
Relationship to Other Projects	Describes how the project may be related to other projects in the ITS Strategic Plan. In some cases, the project could represent an expansion of another project that will be implemented earlier. In other cases, the project could be one component of a larger, multi-faceted strategy, requiring a description of how the project fits into the bigger picture.
Specific Problems or Needs Addressed	Describes how the project addresses problems and needs that have been defined earlier in the process of developing the Strategic Plan.
Traveler and Agency Benefits	Lists specific benefits that will result from the implementation of the project.
Relationship to ITS Market Packages	Provides the linkage back to the ITS Market Packages defined in the Market Package Plan. This helps to identify the relationship to the National ITS Architecture.
Relationship to the Regional ITS Architecture	Describes where the project fits within the overall framework of the Regional ITS Architecture for the Central Coast. The project should be shown, if possible, on architecture diagrams prepared as part of the Strategic Plan.
Time Frame	Identifies when the project would be targeted for implementation. If the project is anticipated to be implemented within the first five years of the Strategic Plan, the year will be specified. Otherwise, the time frame will be specified as 2005 to 2010 or after 2010. Specific implementation years will be resolved at a later date.
Implementing Agency	Identifies the lead agency and supporting agencies. The lead agency will be identified as the one to move the project forward into implementation.
Potential Costs	Develop project-specific cost estimates using the most recent real-world value available. Breakdown the project cost into various components of the project lifecycle. That is, capital investment, project administration, requirements and design, installation and integration, testing and evaluation, and operations and maintenance.
Possible Funding Sources	Funding for most Strategic Plan projects will not have been specifically appropriated. Rather, one or more possible funding sources will be identified. Lead agencies will be responsible for pursuing the funds needed to implement and operate the project.
Follow-up Actions	Describes the subsequent steps that need to be taken to move the project toward implementation. This could include resolution of specific issues ranging from technology to institutional responsibility.

2.2 PLANNING INTERFACE

Many past ITS Projects have been handled as atypical events; that is, they received funding without having to compete against "traditional" transportation projects within the recognized

planning process (es) or programs. Frequently, projects were funded within research and development (R&D) programs or as demonstration projects, operational tests, or proofs-of-concept, without following the transportation planning requirements of current laws and regulations. This approach will not be possible in the future. Under TEA-21 legislation, ITS projects, like other projects, will have to wend their way through the mainstream federal, state, regional, and local planning processes before obtaining funds and moving into the deployment phase. The projects discussed in this plan will need to be considered in subsequent versions of the various regional transportation plans (RTPs) produced for areas within the Central Coast. Projects requiring federal funds must be represented in the applicable RTP and in the appropriate Transportation Improvement Program (TIP): Regional (RTIP), Federal (FTIP), and Statewide (STIP). The specific project requirements and funding sources are needed for the RTIP, FTIP, and STIP, not necessarily for the RTP.

An Advanced Transportation Systems Program Plan published by Caltrans New Technology and Research Program is also a framework to discuss and plan the deployment of ITS technology. This plan needs to operate within the framework of the other plans.

The proponent of each project must determine what funding mechanism will be used, determine the rules of the particular funding program, and then take the actions required to connect the program to the funding source. Particular attention must be paid to meeting the milestone dates required in project calls. Early and continuing liaison with your agency financial staff is important, as always.

2.2.1 Agency Planning Process

The typical agency planning process is organized around the State of California budget cycle as represented in the State fiscal year (July through June). ITS projects in the past have been funded largely with federal funds from Title VI of ISTEA, which supplemented the State Transportation Fund. Future projects are going to have to be a part of the transportation planning process, and the projects must compete for the same transportation dollars as the traditional transportation infrastructure projects.

To assist the Central Coast in its ITS planning efforts, a few key questions have been prepared:

Short- and Long-Term Planning

1. Has an agreed-upon understanding of the project's long-term vision been effectively communicated between all stakeholders and within upper management?
2. Have the long-term goals/policies of the Agency and its ability to support such a project been examined?
3. How do the project and its goals fit within the overall transportation goals of the region?
4. Has an in-depth risk analysis been performed before committing resources (e.g., funding, staff, training, facilities, etc.) necessary for continuing operations, maintenance, and management?
    - Have O&M expectations/consideration been defined?
    - How are you going to operate the system once it is installed (e.g., 24-hours-a-day/7-days-a-week, etc.)?
    - What are the roles/responsibilities within/between Agencies?
    - Who will be the specific staff to manage the system, operate the system, provide system maintenance, etc.?
    - What training will they need?
    - Who will provide such training?
    - How will you retain project knowledge when staff turnover occurs?
    - Will contract maintenance be necessary?
    - Is a process in place to maintain an on-going O&M budget?
5. Where will funding (e.g., capital, O&M, training, etc.) come from (e.g., one Agency, shared between Agencies, etc.)?
6. Has it been confirmed that the identified funds are eligible for the ITS application?
7. Is a process in place to implement projects in a phased/incremental approach?
8. Have "before" and "after" Evaluation needs been considered?

2.2.2 Agency Design Process

Agency design processes vary widely in their details and requirements. Since readers will be doing transportation projects in the State of California, knowledge of the Caltrans project development and design process is important. Extensive written documentation exists and should be obtained prior to undertaking an ITS design. Furthermore, to assist the Central Coast in it's ITS design efforts; a few key questions have been prepared:

Design And Implementation Considerations

1. Are you committed to incorporating a pre-planned, disciplined, end-to-end "Systems Engineering Process" throughout the project life cycle?
    - Are staff trained/skilled to deploy such an undertaking?
    - Are staff trained/skilled to conduct appropriate reviews (e.g., requirements analysis, system designs, acceptance test plans, etc.)?
2. Is commercial off-the-shelf (COTS) equipment available for this application (hardware and software)?
3. Have you examined the COTS products for integrity and suitability before committing to their use?
4. How much software modification will be necessary?
5. Is the design consistent with the National ITS Architecture, California Statewide Architecture, and the Central Coast Regional ITS Architecture?
6. Does the design consider existing and emerging ITS standards and protocols?
7. Have you thought through contingencies?
    - How to deal with communications failures?
    - Do you have an alternate design, system, or technology to "fall-back" on?
    - Provision of system modifications/enhancements?
    - Impacts of new/changes-in technology?
    - Development of risk mitigation strategies?
8. Is the system/project capable of supporting the Evaluation's needs?
9. Is a process in place to allow "visibility" into the project's progress (e.g., scheduled reviews, prototype evaluation, GUI screen development, etc.)?
10. How will you inspect/ensure system/technology installation?
11. How will you determine system/technology "acceptance"?

3. ARCHITECTURE CONSIDERATIONS

3.1 OVERVIEW

This section of the Implementation Guide provides insight into how to put the pieces of the ITS Project puzzle together. Like any puzzle, you need a framework or blueprint from which to work. In the ITS arena, this framework is called the National ITS Architecture.

In this section, we describe what the National Architecture is and looks like; why it is important and useful, and how to use it within the ITS strategic planning process. In addition, Section 3 discusses the need for the Central Coast's ITS activities to be in conformance with the National ITS Architecture in terms of developing a Regional ITS Architecture and it's associated functional, physical, organizational, and data flow components, coordination with neighboring regions and jurisdictions, and funding eligibility.

The primary objective of this section is to "de-mystify" the National ITS Architecture and translate its components into practical applications tailored to the Central Coast. In this manner, Central Coast stakeholders will have a better understanding of what the Architecture can do for them now and in the future. To this end, the contents of this section have been carefully chosen, descriptions presented in simple layman's terms, and diagrams used extensively to illustrate key points. Section 3 presents an overview look at the Architecture, highlighting key points and providing an initial level-of-detail to further illustrate how useful the Architecture is to the ITS practitioner at the project level. In addition, step-by-step instructions are provided on how the Regional ITS Architecture for the Central Coast was developed and how to use the Architecture for future project planning efforts.

3.2 WHAT IS AN ARCHITECTURE?

> ***"In its most basic form, an architecture is a set of rules that facilitates the building of systems and that allow these systems to communicate and inter-operate after being built."***

What is an architecture and why is it important to know about architectures? In its most basic form, an architecture is a set of rules that facilitates the building of systems and that allows these systems to communicate and inter-operate after being built. An ITS architect is to an ITS system as a building architect is to a building. A building architect could not build a structure without a set of plans. Neither could an ITS architect build a complex ITS environment without a set of plans. These plans are the system architecture.

An architecture is important in the development of complex systems because it provides detailed guidance on how to design the systems and because it provides a vehicle to decompose larger systems into more understandable subsystems. An architecture is particularly important if more than one system is to be built and these systems must talk to each other or if multiple systems will be expanded over a period of time. In the Central Coast, both of these elements are clearly present.

The first step of a complex systems development process is to develop the architecture. To develop the architecture we first need to know what the system users need, that is, what are their requirements? What do they want the system to do? As you recall, the Central Coast's user needs were defined in Project Task 2 and presented in Chapter 2 of Volume I - ITS Strategic Plan. At this point, the details of physical elements such as communications links, traffic signals, and TMC's are not important. The next step is to take these user requirements and develop system requirements. Now the emphasis is on what the proposed system must do to meet the users' needs. In the process of developing system requirements, we determine what functions must be performed by the system and what data/information must flow between the functions. The Central Coast's required functionality is represented by Market Packages and their selection presented in Chapter 3 of Volume I - ITS Strategic Plan. For example, if a function of "Broadcast Traveler Information" is defined, we need to know what data is input into the function, what data is output from the function, and where these data flows are routed. The final step in the architecture development process is to allocate the functions to hardware, software, or human operators. This last step is commonly referred to as high-level design.

It is important to distinguish between an architecture built for planning and implementation guidance and an architecture used to design and build actual working systems. In our discussions

regarding this Strategic Plan, the former context is most appropriate, although a few insights will be provided on the latter.

3.3 WHAT IS THE NATIONAL ARCHITECTURE?

3.3.1 What Does It Do?

Since 1992, the U. S. DOT has been engaged in the development of the National ITS Architecture. Basically, it provides a framework and common vocabulary for planning, defining, and integrating ITS systems among modes of travel and geographic areas. The set-of-tools that comprise the National ITS Architecture provide a common information source in the following manner:

- Framework to identify system components and interconnections
- Vocabulary to better communicate with colleagues
- Guidance to help develop a regional ITS architecture, and to identify integration opportunities during project definition

Furthermore, Section 5206 (e) of TEA-21 requires that ITS Projects carried out using funds made available by the Highway Trust Fund conform to the National ITS Architecture, applicable provisional standards, and protocols. This is now more commonly referred to as "conformance" with the National ITS Architecture.

3.3.2 What Is It Made Of?

The National ITS Architecture's main objectives are to describe what functions/processes are needed, decide where these functions should be located, and identify who needs to be involved and/or is responsible. The principal components that make-up the Architecture and their primary role(s) are described in Exhibit 3.1.

Exhibit 3.1 – National ITS Architecture Component Description

Component	Description
User Services	• Identifies current and future needs and/or services to address/implement
Market Packages	• Pieces of the architecture that provide a particular transportation service • Describes what functions to perform
Logical Architecture	• Describes what functions/processes are needed • Indicates data/information flows between functions/processes
Physical Architecture	• Groups/allocates functions to subsystems • Identifies the physical interfaces for which to develop standards
Organizational Architecture	• Groups/allocates subsystems by Agency ownership • Describes who will be interconnected to one another for data/information sharing purposes
Architecture Flows	• Identifies what data/information flows exist between subsystems
Subsystems	• Transportation-related components that makeup the Physical Architecture • Typically classified into four (4) categories; Center, Roadside, Vehicle, and Traveler

Basically, the Architecture consists of a series of diagrams/figures that show the relationships within/between components, subsystems, and Agencies. Within the Architecture, these diagrams represent sample figures that can be tailored to a specific region such as the Central Coast. In subsequent sections of this chapter, the specific components of the Architecture that are used to show the Central Coast's conformance to the Architecture are further defined and diagrams uniquely tailored.

3.3.3 Why Is It Useful?

"Conformance with the National ITS Architecture ensures that ITS Projects in the Central Coast are eligible for Federal funding."

The Central Coast should make use of the U. S. DOT's investment in the National ITS Architecture to develop a tailored Regional ITS Architecture that establishes a framework for deployment to guide Central Coast stakeholders. A Regional ITS Architecture has the potential to provide the following benefits:

- Ensure that ITS projects meet TEA-21's Architecture conformance requirements for Federal funding eligibility
- Lower costs and risk, both during design and over the entire project life-cycle
- Reduced development time
- Orderly and efficient expansion of systems/technologies
- Economies-of-scale by using technologies from multiple vendors that can still work together as a system
- Highlight and improve the integration of systems
- Use of a common set of standards to better coordinate operations, integrate systems, and share data/information
- Identify potential stakeholders interested in sharing data/information, thereby assisting in the current and future project planning and implementation process
- More coordinated operations among different Agencies across the region

Because of these benefits, the times to use the National ITS Architecture are as follows:

- At the *beginning* of the ITS strategic planning process when developing a regional architecture as a reference for transportation planning
- Defining a project to be integrated within a region
- Examining options for expanding existing capabilities

3.4 REGIONAL ITS ARCHITECTURE FOR THE CENTRAL COAST

3.4.1 What Is It?

The Regional ITS Architecture is a description of "what" we want to do in the Central Coast. It describes the planned ITS services and functions, incorporates the relevant subsystems and organizations, and describes the information exchanges planned between them. In the Central Coast, these relationships are illustrated by tailoring specific National ITS Architecture diagrams. From these tailored diagrams, a deployment plan structure is established that provides a basis for long-term transportation planning in the region. From this, mainstreaming ITS

"The Central Coast Regional ITS Architecture is created by tailoring specific National ITS Architecture diagrams"

Projects into the planning process and promoting stakeholder buy-in across organizations should be easier since everyone is working-off-the-same-blueprint.

Another purpose of the Central Coast Regional ITS Architecture is to describe how individual ITS Projects and applications work together as a system. In this manner, the National ITS Architecture was tailored to reflect the list of ITS Projects selected for the region. Therefore, the Central Coast Regional ITS Architecture was designed to accommodate anticipated projects (as described in Chapter 3, Volume I), and vice-versa.

3.4.2 How Was It Developed?

Exhibit 3.2 illustrates "how " the National ITS Architecture was used to develop a Regional Framework for the Central Coast. Basically, the first column (or Activity) represents the steps taken, the second column (or Arrows) represents the part of the National ITS Architecture used, and the third column (or Product) represents the deliverable. In addition, Exhibit 3.2 can be used as a roadmap to find out where in this section of Volume II specific Architecture tailoring activities are more fully described. The following paragraphs present a brief discussion of each of the five (5) key steps/activities that form the basic process used to develop the Central Coast Regional ITS Architecture:

Activity #1 -- Inventory Existing Systems. This activity maps the Central Coast's existing ITS systems to the National ITS Architecture's "sausage" diagram (or Physical Architecture). This mapping exercise is detailed in Section 3.6.

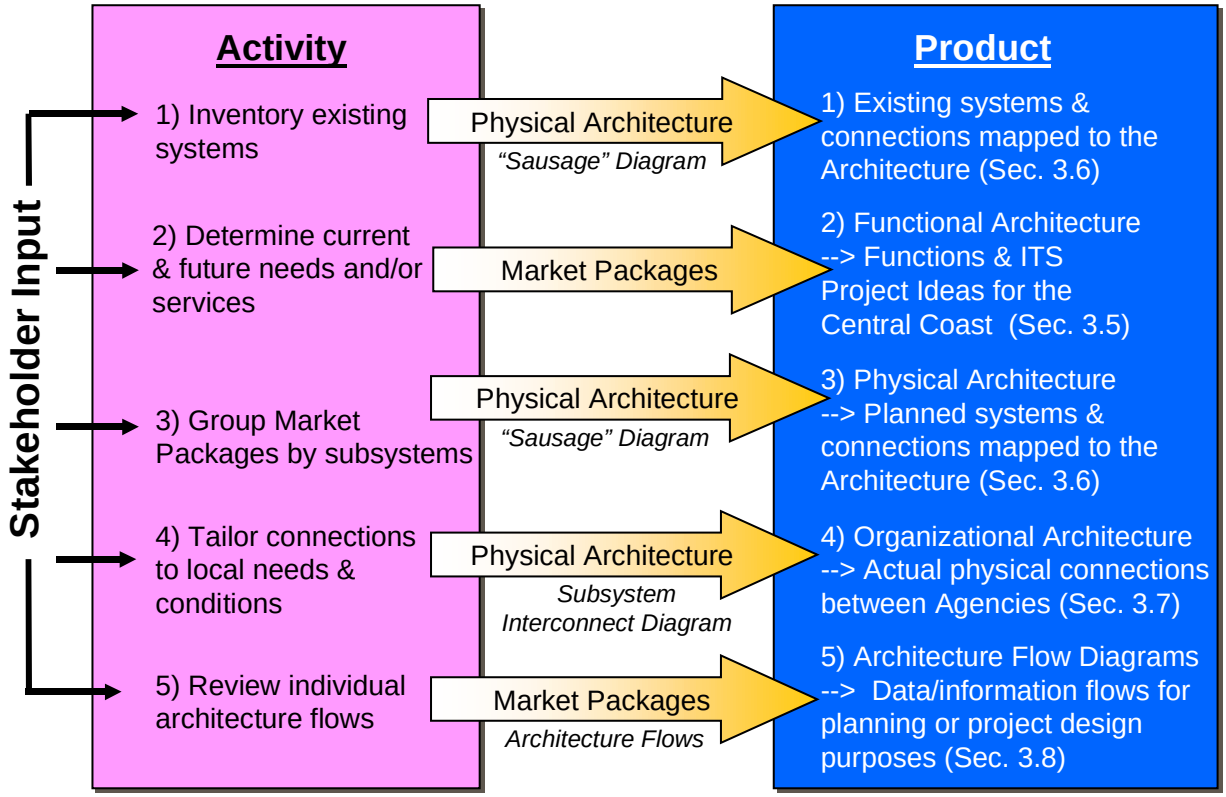
Activity #2 -- Determine Current & Future Needs and/or Services. In Section 3.5, the Market Packages selected for the Central Coast are graphically illustrated to show how they evolve into full-blown ITS Projects. This evolution is represented/illustrated through a series of relational diagrams that comprise the Functional Architecture.

Activity #3 -- Group Market Packages by Subsystems. Using the work performed in Section 3.5 as the foundation, both selected Market Packages and proposed ITS Projects are shown as they relate to the Physical Architecture. This mapping exercise can be found in Section 3.6.

Activity #4 -- Tailor Connections to Local Needs and Conditions. In tandem with establishing the Physical Architecture interconnections (in Section 3.6), the hierarchy of these desired connections is graphically illustrated to get a sense of "who's-talking-to-who". This tailoring exercise can be found in Section 3.7

Activity #5 -- Review Individual Architecture Flows. Using the Market Packages selected for the Central Coast, their data/information flows are tailored to the desired level of system interaction. This tailoring exercise can be found in Section 3.8.

Exhibit 3.2 – How the National ITS Architecture was used to Develop the Central Coast Regional ITS Architecture



The Central Coast Regional ITS Architecture is made-up of four (4) primary components:

1. Functional Architecture
2. Physical Architecture
3. Organizational Architecture
4. Architecture Flow Diagrams

The following sections provide a detailed description of these specific components. In addition, step-by-step instructions on how the Central Coast Regional ITS Architecture was developed will also be presented. Diagrams for each of these four (4) components (as appropriate) will be partitioned for the Central Coast stakeholders in the following manner:

- Appendix A – Central Coast Region
- Appendix B – Santa Cruz County
- Appendix C – San Benito County
- Appendix D – Monterey County
- Appendix E – San Luis Obispo County
- Appendix F – Santa Barbara County
- Appendix G - AMBAG

3.5 FUNCTIONAL ARCHITECTURE

3.5.1 What Is It?

To describe the Central Coast's Functional Architecture, the key tools used throughout are Market Packages. Therefore, the region's Functional Architecture describes and/or depicts the following:

- Describes what functions will be performed
- Shows the relationship between Market Packages (categories and individual ones) within the Central Coast Regional ITS Architecture
- Shows where ITS Projects fit-in
- Provides a representative look at data/information sharing between functions

In Volume 1 (Chapter 3), both Market Package categories as well as individual Market Packages were selected for inclusion in the Central Coast. Therefore, the functions to perform as well as specific ITS Projects how to perform them have already been established. The sections that follow therefore focus on graphically depicting the relationships between Market Packages and ITS Projects. This step and resulting diagrams were developed as a prelude to the Central Coast's Physical Architecture in order to ease the transition from Market Packages to subsystems, data flows, and interconnections.

3.5.2 Why Is It Useful?

The Functional Architecture is useful to the Central Coast's stakeholders for the following reasons:

- Eases the transition from Market Packages to both the Physical and Organizational Architectures

- Describes functional connections and intimates upcoming physical and Agency connections
- Establishes the initial architecture relationships between Market Packages and ITS Projects

3.5.3 Regional Market Package View

"The Central Coast's Functional Architecture was developed as a prelude to the Physical Architecture to ease the transition from Market Packages to subsystems, data flows, and interconnections.

Exhibit 3.3 depicts the "high-level" relationships between Market Package categories selected for inclusion in the Central Coast. It was developed by analyzing the Central Coast Market Package Plan, and then using the National ITS Architecture to identify the architectural framework that supports these "generic" Market Package categories. Basically, three primary pieces of information are shown in Exhibit 3.3:

- Market Package categories
- Data flow direction(s)
- Representative data flows

The relationships depicted in Exhibit 3.3 support intended interconnections by establishing the links between Market Package categories and the direction(s) that data will flow over those links. The data flows presented in the diagram provide a sample of what information could be shared/transmitted between the Market Package categories. Please note that both data flow direction(s) and type as presented in Exhibit 3.3 are representative, not all-inclusive. The in-depth look at data/information sharing between Market Packages is presented in Section 3.8 Architecture Flow Diagrams.

In Exhibit 3.3, please note that all the Market Package category names depicted are not those found in the National ITS Architecture. The Central Coast has elected to tailor some of the names of their Market Package categories to better reflect their particular interests (an action supported by the National ITS Architecture). These relationships are presented in Exhibit 3.4.

Exhibit 3.3 – Regional Market Package View

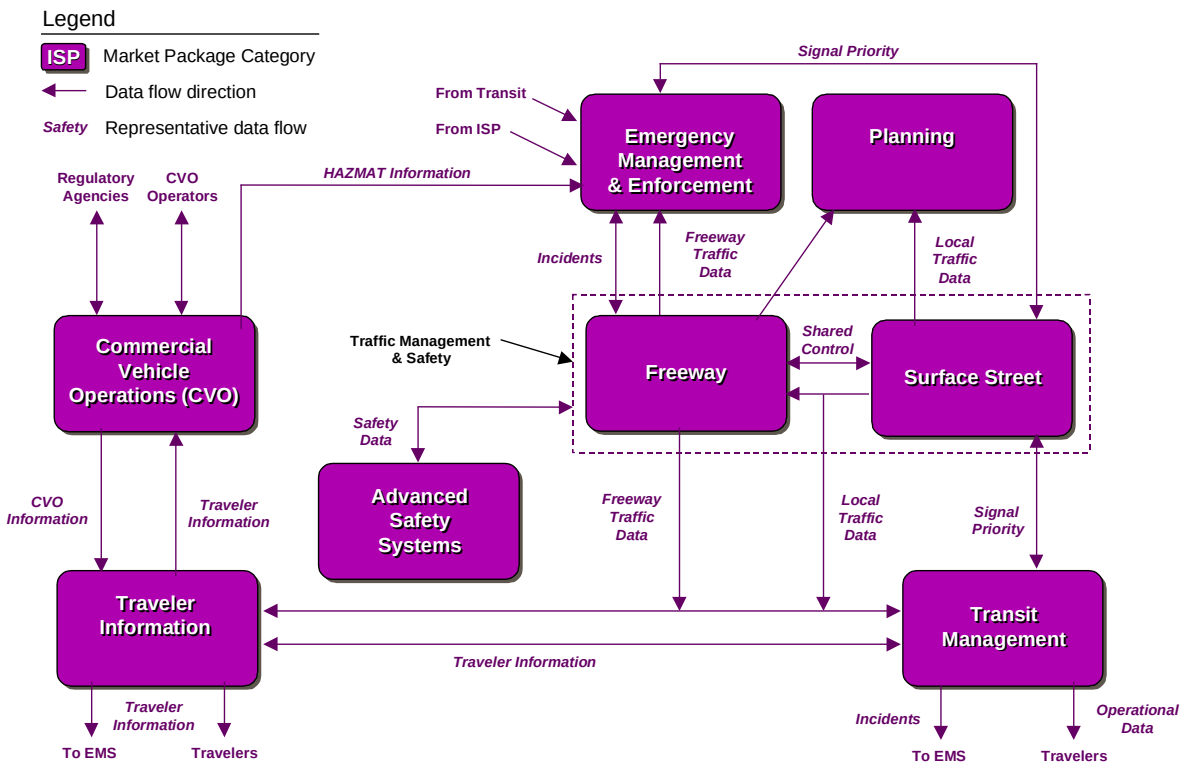


Exhibit 3.4 - Market Package Category Relationships

Central Coast	National ITS Architecture
Traffic Management and Safety	Traffic Management Advanced Vehicle Safety System (AVSS)
Transit Management	Public Transportation
Traveler Information	Traveler Information
Commercial Vehicle Operations (CVO)	Commercial Vehicle Operations (CVO)
Emergency Management and Enforcement	Emergency Management
Planning	ITS Planning

The steps that follow focus on graphically depicting the Functional Architecture's relationships between Market Packages and ITS Project Ideas as depicted in Exhibit 3.3. These steps and resulting diagram were performed as a prelude to developing the Central Coast's Physical

Architecture in order to ease the transition from Market Packages to subsystems, data flows, and interconnections.

How to Develop the Regional Market Package View

1. Analyze the Central Coast Market Package Plan
    - Determine Market Package categories for inclusion
    - Tailor the names of the Market Package categories from the National ITS Architecture to the Central Coast (as necessary)
2. Establish representative data flow links/interconnections between Market Package categories
3. Establish the directions(s) that data/information will flow over those links
4. Establish representative data type(s) to flow over those links

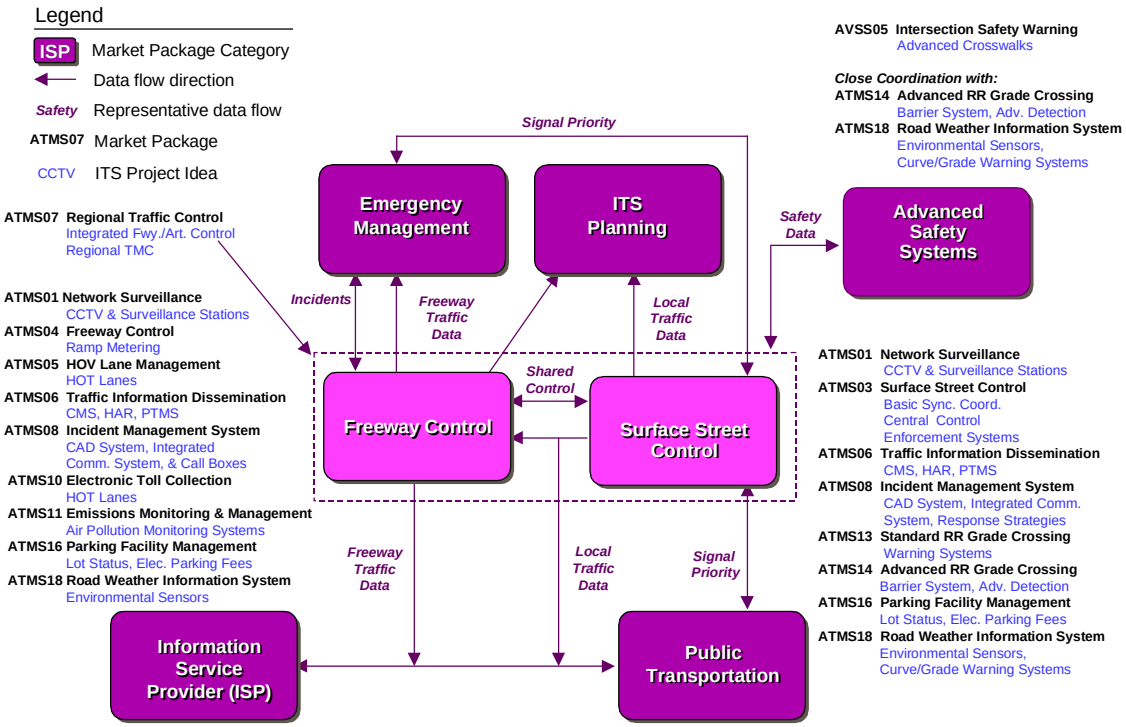
3.5.4 Individual Market Package View

The next step in developing the Central Coast's Functional Architecture is to add detail and tailor this Regional View to individual Market Packages. Basically, this just means that we focus on one of the six Market Package Categories at a time, adding in the individual Market packages and ITS Project Ideas that are a part of that category. This step is intended to provide a sense/view of how everything will work together by describing functional interconnections and intimating upcoming physical connections. Exhibit 3.5 shows the individual Market Package view for the "Traffic Management & Safety" category. Basically, five primary pieces of information are shown:

- Market Package Categories
- Associated ITS Projects
- Representative data flows
- Individual Market Packages
- Data flow direction(s)

The primary Market Package categories are shown either centered and/or shaded. For the primary category, the individual Market Package(s) are listed to the side of each related category by both the National ITS Architecture name and coding shorthand.

Exhibit 3.5 – Individual Market Package View (Traffic Management and Safety)



Below each identified Market Package is a listing of the associated ITS Project Idea(s). Please note that both data flow direction(s) and type as presented in Exhibit 3.5 are representative, not all-inclusive. The in-depth look at data/information sharing between Market Packages is presented in Section 3.8 "Architecture Flow Diagrams". Similar diagrams to Exhibit 3.5 have also been developed for the Central Coast's remaining five Market Package categories. These can be found in Volume II - Appendix A.

The steps that follow focus on graphically depicting the Functional Architecture's relationships between Market Packages and ITS Project Ideas as depicted in Exhibit 3.5 (and found in Appendix A). These steps and resulting diagrams were performed as a prelude to developing the Central Coast's Physical Architecture in order to ease the transition from Market Packages to subsystems, data flows, and interconnections.

How to Develop the Individual Market Package View

1. Select a single Market Package category to tailor
2. Depict representative data flow links, types, and direction between related Market Package categories

3. Add/list the individual Market Package(s) to the side of each related category by:
    - National ITS Architecture name
    - National ITS Architecture coding shorthand
4. Below each identified Market Package, list the associated ITS Project Idea(s)

3.6 PHYSICAL ARCHITECTURE

3.6.1 What Is It?

"The Physical Architecture's primary purpose is to group/allocate the Central Coast's selected functions (or Market Packages) to physical subsystems ."

The major building block of the National ITS Architecture is the Physical Architecture. The Physical Architecture's primary purpose is to group/allocate the Central Coast's selected functions (or Market Packages) to physical subsystems. Once this is complete, the Physical Architecture then provides the initial look at establishing the interconnections between various subsystems. The Physical Architecture's make-up is described in Exhibit 3.6.

The Physical Architecture is typically represented by Exhibit 3.7, otherwise known as the "sausage" diagram (for the shape of the communication links). From Exhibit 3.7, specific types of subsystems are identified for each of the four subsystem classes as well as their interconnections (end-users are not represented in the "sausage" diagram). Because this is an "ideal" diagram, all connections are shown.

3.6.2 Why Is It Useful?

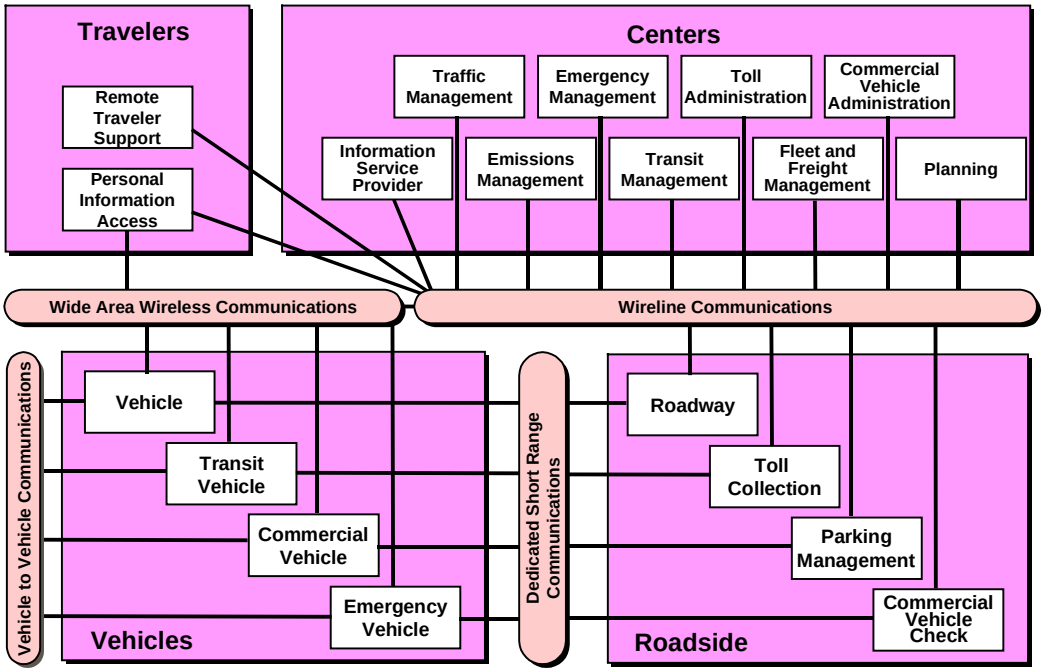
The Physical Architecture is useful to the Central Coast's stakeholders for the following reasons:

- Groups/allocates functions and ITS Project Ideas
- Establishes the initial physical connections between Agency subsystems
- Provides key materials/diagrams to establish conformance with the National ITS Architecture

Exhibit 3.6 - Physical Architecture Description

National ITS Architecture Component	Definition	Example
Subsystem	Collection of functions within a single institutional boundary that correspond with physical transportation systems in four (4) classes: • Center • Roadside Infrastructure • Vehicles • Travelers	Center • Caltrans D5 TMX • City of Santa Cruz Traffic Signal System • CHP Dispatch Center Roadside Infrastructure • CCTV • Smart Call-Box • CMS Vehicles • Transit fleet management/vehicle location system • CVO electronic clearance • Emergency vehicle signal priority Travelers • Internet/web-site • Kiosks • Telephone call-in system
End-Users (or Terminators)	An interface to the Physical Architecture from the rest of the world (i.e. non-architecture components) in three (3) types: • Environment • Operators/people • Related systems	Environment • Visibility conditions • Pavement temperature Operators/People • TMC Operator • Traveler/motorist Related System • Weather Service Provider • Construction and Maintenance
Communications	Provides the connections necessary for the subsystems and end-users to interact and share data with one another through four (4) components: • Fixed point-to-point (or wireline) • Wide-area wireless (or mobile) • Dedicated short-range communications (DSRC) • Vehicle-to-vehicle	Wireline • Fiber optic • Twister pair • Telephone lines Mobile • Cellular • Spread spectrum radio DSRC • Radio frequencies • Typically used for CVO and toll collection activities Vehicle-to-vehicle • Radio frequencies • Typically used for collision warning systems

Exhibit 3.7 - National ITS Architecture "Sausage" Diagram – Physical Architecture Subsystems and Interconnects



3.6.3 What It Looks Like - Regional View

The first job was to tailor the "sausage" diagram to reflect those subsystem components and interconnections selected for the entire Central Coast region. It was decided that the best way to tailor this information was to present it in three different ways (or diagrams):

- Existing system
- Proposed systems
- Combined systems (both existing and proposed)

In this manner, the Central Coast will be able to see what they already have (existing), what they want (proposed), and what they will eventually end-up with (combined). Therefore, separate "sausage" diagrams have been created at the Central Coast regional level for each of the above areas. Exhibit 3.8 presents the "sausage" diagram as tailored to reflect the Central Coast's existing regional view. Exhibit 3.9 presents the Central Coast's proposed regional view. Basically for the combined view, the existing and proposed diagrams were just overlaid on top of one another. Exhibit 3.10 the Central Coast's combined regional view.

Exhibit 3.8 - Central Coast Physical Architecture – Existing Regional View

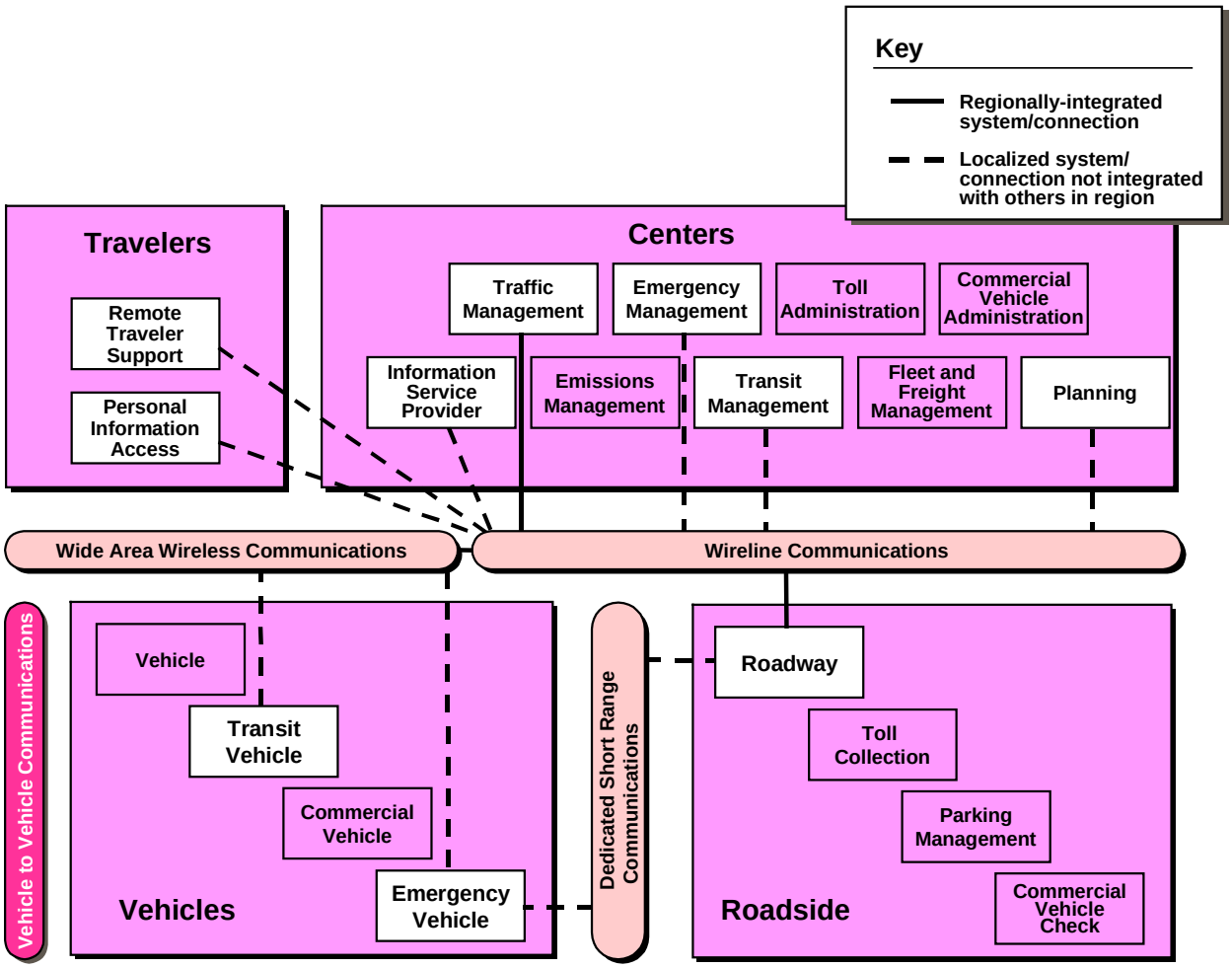


Exhibit 3.9 - Central Coast Physical Architecture – Proposed Regional View

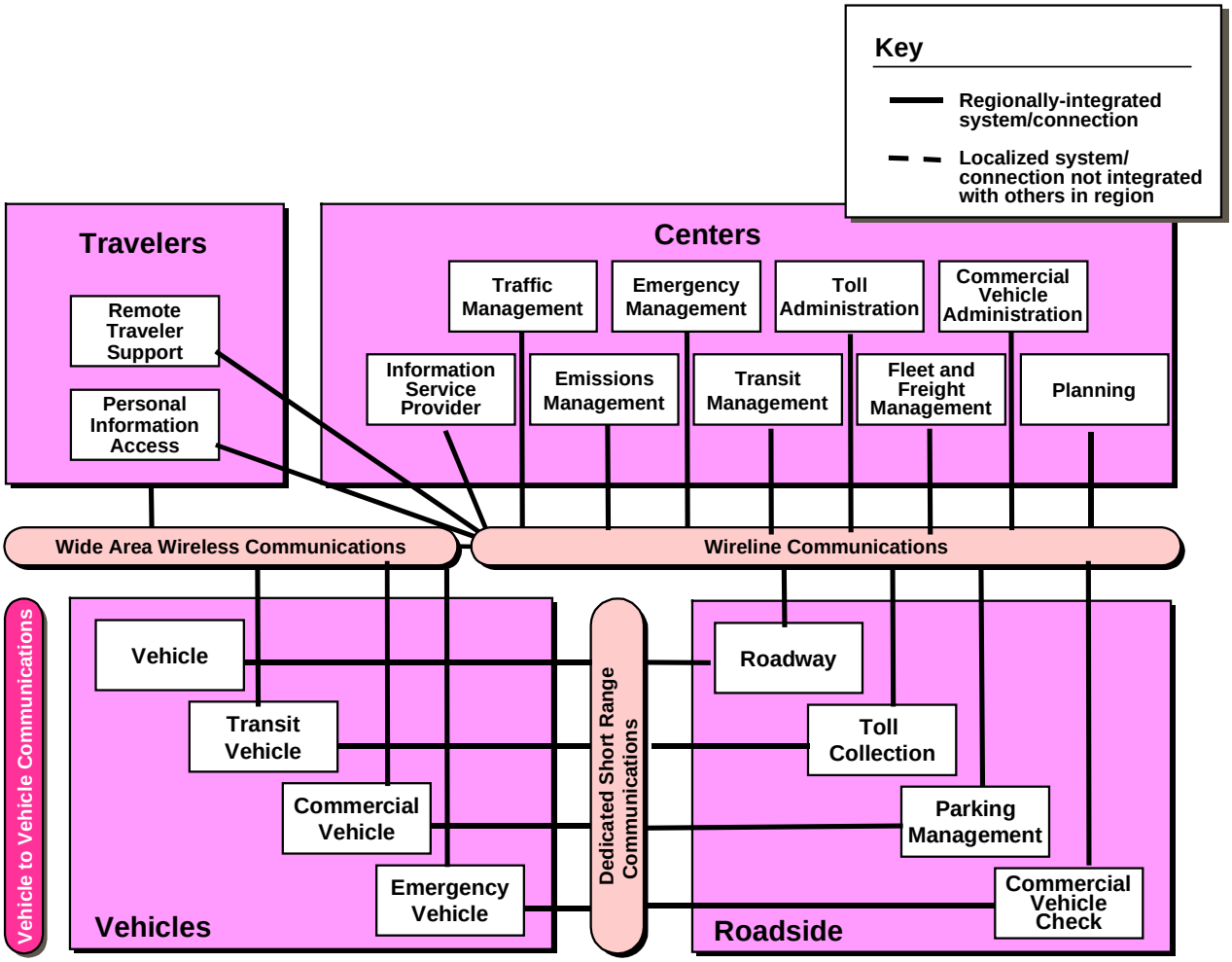
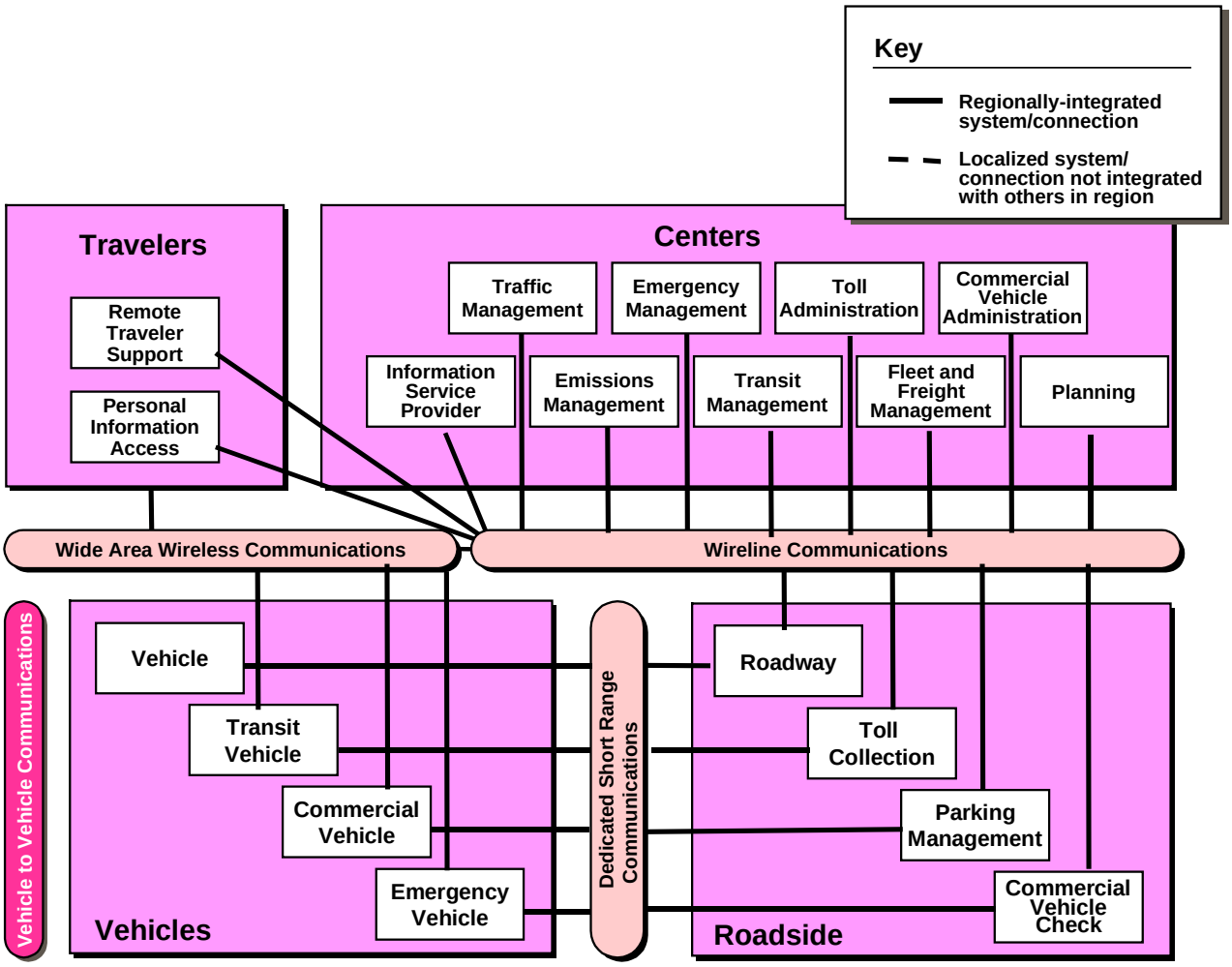


Exhibit 3.10 - Central Coast Physical Architecture – Combined Regional View



The steps that follow focus on graphically depicting the relationships between the National ITS Architecture's "sausage" diagram (or Physical Architecture) and the Central Coast's:

- Existing ITS systems
- Selected Market Packages
- Identified ITS Project Ideas

How to Develop the Physical Architecture (Regional View)

1. Develop diagrams tailored for three (3) distinct system views:
    - Existing
    - Proposed
    - Combined (both existing and proposed)
2. Existing
    - Enter existing systems and interconnects for all five (5) Central Coast counties into an inventory list
    - Analyze Market Package subsystems and interconnects selected for inclusion in the Central Coast
    - Analyze the list and determine if there is a subsystem or interconnect that matches the sausage diagram
    - If there is a match, the subsystem or interconnect remains on the diagram
    - If no match, remove subsystem or interconnect from diagram
    - Tailor subsystem or interconnect into local or regional reference
3. Proposed
    - Analyze Market Package subsystems and interconnects selected for inclusion in the Central Coast
    - Analyze the list and determine if there is a subsystem or interconnect that matches the sausage diagram
    - If there is a match, the subsystem or interconnect remains on the diagram
    - If no match, remove subsystem or interconnect from diagram
    - Tailor subsystem or interconnect into local or regional reference
4. Combined
    - Overlay the existing and proposed diagrams on top of one another

3.6.4 What It Looks Like - County-by-County View

The next step was to take the Central Coast Regional View and tailor these to a specific county. This means that existing, proposed, and combined "sausage" diagrams were tailored for each of the five counties in the Central Coast. What separates these views from the Regional View is that additional levels-of-detail are provided to further strengthen the bond between Market Packages, ITS Project Ideas, and the Regional ITS Architecture. Individual Market Packages within each subsystem as well as specific Agency-owned components (or ITS Project Ideas) within each Market Package are presented. Exhibit 3.11 presents the "sausage" diagram as tailored to reflect Santa Cruz County's existing view. Please refer to the appropriate Appendix (Volume II) for the full suite of tailored "sausage" diagrams for each Central Coast County.

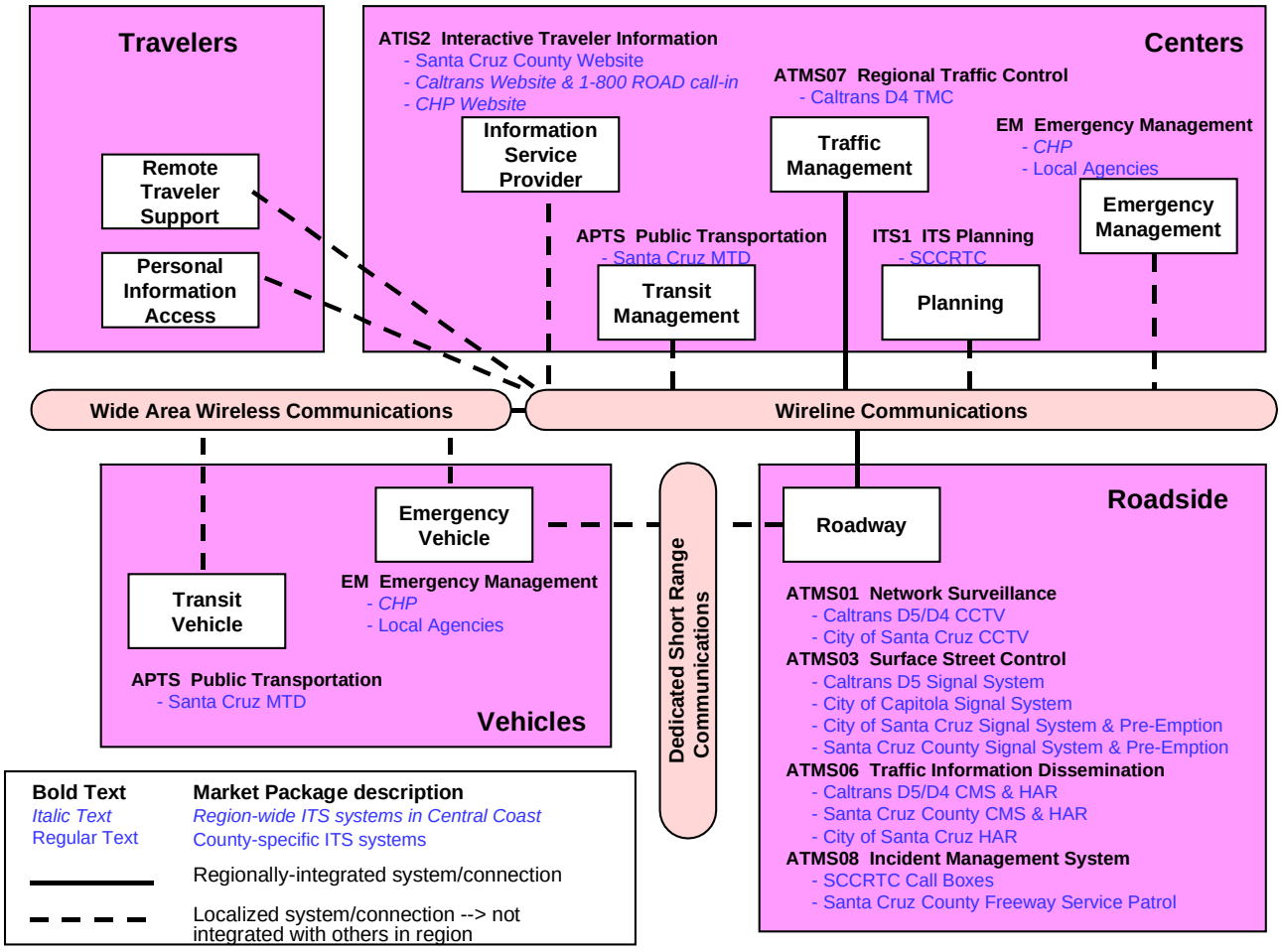
The steps that follow focus on graphically depicting the relationships between the National ITS Architecture's "sausage" diagram (or Physical Architecture) and the Central Coast's:

- Existing ITS systems
- Selected Market Packages
- Identified ITS Project Ideas

How to Develop the Physical Architecture County-by-County View

1. Develop diagrams tailored to each of the five (5) Central Coast counties for three (3) distinct system views
   - Existing
   - Proposed
   - Combined (both existing and proposed)
2. Existing
   - Same as Regional View (Existing) as tailored to a specific county
   - Add/list the individual Market Package(s) to the side of each related subsystem by:
     - National ITS Architecture name
     - National ITS Architecture coding shorthand
     - Below each identified Market Package, list the existing ITS system(s)
3. Proposed
   - Same as Regional View (Proposed) as tailored to a specific county
   - Add/list the individual Market Package(s) to the side of each related subsystem by:
     - National ITS Architecture name
     - National ITS Architecture coding shorthand
   - Below each identified Market Package, list the ITS Project Idea(s)
4. Combined
   - Same as Regional View (Combined) as tailored to a specific county

Exhibit 3.11 - Santa Cruz County – Existing Systems/Centers



3.7 ORGANIZATIONAL ARCHITECTURE

3.7.1 What Is It?

"The main reason behind developing an Organizational Architecture for the Central Coast region is to determine just "who" will be connected to one another.

The main reason behind developing an Organizational Architecture for the Central Coast region is to determine just "who" will be connected to one another. In this sense, "connected" means what Agency systems will be physically linked by communications, and therefore, what Agency systems are sharing data. While developing the Physical Architecture in the previous section, an initial indication of who was the owning and/or responsible Agency was provided. The Organizational Architecture takes this one step further by explicitly grouping each subsystem by Agency ownership, establishing the "actual" physical interconnections (not just representative ones as provided in the "sausage" diagram), and graphically illustrating the Agency/subsystem hierarchy through a series of interconnect diagrams.

3.7.2 Why Is It Useful?

The Organizational Architecture is useful to the Central Coast's stakeholders for the following reasons:

- Groups subsystems by Agency ownership
- Depicts which Agency subsystems are connected to one another
- Provides an initial indication of the hierarchical relationships that exist for the Central Coast Agencies

3.7.3 What Does It Look Like?

Basically, the Organizational Architecture diagrams will look like a series of Agency-owned systems linked/connected to other Agency-owned systems. The key is determining the appropriate sequence/relationship(s) that indicate "who's-talking-to-who". The process used to develop the Organizational Architecture is as follows:

- Perform an information flow analysis (Please refer to Volume II - Section 3.7.4)
- Analyze the Central Coast's Physical Architecture (Please refer to Volume II - Section 3.6)
- Review the TMC guiding principles (Please refer to Volume I - Section 3.4)

- Use the FHWA's database tool called "Turbo Architecture" (or Turbo) to tailor Agency relationships in the Central Coast

Turbo is a high-level, interactive software program created by the FHWA and Architecture Development Team to facilitate usage of the National ITS Architecture. The application utilizes user inputs and the National ITS Architecture databases to provide users with tabular and graphical outputs comprising a high-level representation of their Regional or Project Architecture. Turbo identifies and extracts the required portions of the National ITS Architecture to assist in the local mapping and tailoring of a region's needs. At this time, the FHWA has not officially released Turbo for use. Upon Turbo's release, the Central Coast's Organization Architecture will be finalized.

For the Central Coast, seven Organizational Architecture diagrams will be developed. One for each county, one for AMBAG, and one for the entire Central Coast region. These can be found in the appropriate Appendix section (Volume II). For now, Exhibit 3.12 provides a representative example of what these diagrams will look like.

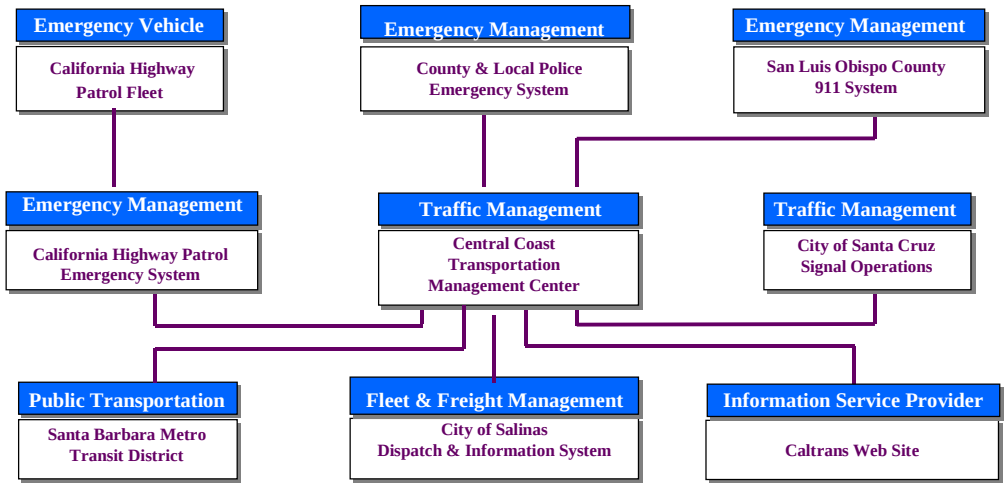
3.7.4 How to Develop the Organizational Architecture

The steps that follow focus on graphically depicting the institutional relationships in the Central Coast. The Organizational Architecture explicitly groups each subsystem by Agency ownership, establishes the actual physical interconnections (not just representative ones as provided in the sausage diagram), and graphically illustrates the Agency/subsystem hierarchy through a series of interconnect diagrams.

Information Flow Analysis

1. Break-down the ITS Project Ideas into three (3) distinct categories
   - Data sources – roadway sensors, CCTV, etc.
   - Control elements – ramp meters, traffic signals, etc.
   - Dissemination outlets – CMS, HAR, Internet website, kiosks, etc.
2. Identify all of the potential system end-users of the data/information
   - Sometimes, multiple users will be interested in a single piece of data/information
   - For example, traffic information is usually of interest to a broad audience, ranging from the travelers themselves to the Agencies that are responsible for maintaining traffic flow

Exhibit 3.12 - Central Coast Organizational Architecture - Representative View



3. Establish a matrix that show linkages between the ITS applications and system end-users by depicting the associated data/information flows by the Agency's intended role/use of the data

   - PC - Primary Control indicates the User who owns the system/project and is responsible for its O&M. Basically, the User needs this information as part of its day-to-day operations.
   - SC - Secondary Control indicates a User who, in the absence of the owner, will expand its role to be in-charge. In addition, this shared data/information is critical to its operations so they have established dedicated communication links to ensure its transmittal.
   - PS - Primary Share indicates a User who needs the data/information as an integral part of its operations and has established dedicated communication links to ensure its transmittal.
   - SS - Secondary Share indicates a User who wants the data/information because they believe it will be useful to their operations.
   - EU - End-User indicates a User who receives the data/information as a means to improve their ability to traverse the transportation network
   - Exhibits 3.13, 3.14, and 3.15 depict the information flow analysis for the Data Sources, Control Elements, and Dissemination Outlets, respectively. These matrices provide a key input to developing the graphic diagrams that depict the Organizational Architecture because they indicate "where" physical connections are necessary and begin to establish the hierarchy (i.e., "who's-to-talking-to-who") among involved Agencies/Users

Exhibit 3.13 – Information Flow Analysis (Data Sources)

		POTENTIAL SYSTEM USERS																					
ITS APPLICATION	LOCATION	Caltrans D5	CHP	MPOs/RTPAs	City/County Traffic Eng.	City/County Planning	City/County Law Enforcement	Transit Providers (Public Agency)	Transit Providers (Private Sector)	Rail Organizations (Public Agency)	Rail Organizations (Private Sector)	EMS Providers	CVO Carriers	ISPs/Media	AQMD/APCD	Tourism Boards	Towing Services	Rental Car Companies	Activity Centers/Special Events	Parking Facilities	CA Office of Motor Carriers	Travelers
CCTV Cameras																						
	State roadways	PC	SC	PS	SC		SC	PS	EU	SS	EU	SC	EU	PS			EU	EU				EU
	Local arterials	SC	EU	PS	PC		SC	PS	EU	SS	EU	SC	EU	PS			EU	EU				EU
	Activity centers/special events	SC	EU	SS	SC		PS	SS	EU	EU	EU	SC	EU	PS		EU	EU	EU	PC	SS		EU
Surveillance Stations																						
	State roadways	PC	SS	SS	SC	SS	SS	SS	EU	EU	EU	PS	EU	PS	SS		EU	EU				EU
	Local arterials	SC	EU	SS	PC	SS	SS	SS	EU	EU	EU	PS	EU	PS	SS		EU	EU				EU
	Activity centers/special events	SC	EU	SS	SC	SS	SS	SS	EU	EU	EU	PS	EU	PS	SS	EU	EU	EU	PC	SS		EU
Environmental Sensors																						
	State roadways	PC	PS	SS	SC	SS	SS	SS	EU	EU	EU	PS	EU	PS	SS		EU	EU				EU
	Local arterials	SC	EU	SS	PC	SS	PS	SS	EU	EU	EU	PS	EU	PS	SS		EU	EU				EU
"Smart" Call Boxes																						
	State roadways	PC	SS	PC	PS	SS	SC	SS		EU	EU	PS	EU	PS	SS		SS	EU				EU
Call Boxes																						
	State roadways	PS	PC	SS			SC					PS		SS			SS	EU				EU
*Telephone Call-In System (*11)*																						
	Region-wide	SC	PC		PS		PS		EU			PS	EU	PS			SS	EU				EU
	County-specific	SS	SC	SS	PS	SS	PC		EU			PS	EU	PS			SS	EU				EU
AVL System																						
	Agency-specific	PC	PC		PC		PC	PC	PC	PC	PC	PC	PC				PC	PC				
MAYDAY System																						
	Region-wide		SC				PS					PS		SS			PS	EU				EU
Automated Passenger Counting (APC)																						
	Agency-specific			SS		SS		PC	PC	PC	PC			SS								
Electronic Fare Payment/Smart Cards																						
	Parking facilities			PS		SS												EU	PS	PC		EU
	Transit/rail providers			PS		SS		PC	PC	PC	PC											EU
On-Board Diagnostic System																						
	Agency-specific	PC		SS	PC		PC	PC	PC	PC	PC	PC	PC		SS		PC	PC				
Security Monitoring																						
	Agency-specific		PC				PS	PC	PC	PC	PC							PC	PC	PC		

NOTES:

1) There exists the need and/or potential for data/information sharing with other Caltrans' Districts (as appropriate)
2) For "State Roadways", Caltrans is assumed to "own" the data/information and "shares" with other agencies per MOUs
3) For "Local Arterials", individual agencies are assumed to "own" the data/information and "share" with other agencies per MOUs
4) Data/information is assumed to be in "raw" form for the owning agency and "smoothed" when distributed to a sharing agency or travelers
5) Specific/directional information flows will be depicted within subsequent Data Flow Diagrams (DFDs)
6) The "Traveler" column is considered to be the motoring public
7) Information flow analysis assumes the use of dedicated agency workstations and an integrated communications network throughout the Central Coast

LEGEND:

PC --> Primary Control
SC --> Secondary Control
PS --> Primary Share
SS --> Secondary Share
EU --> End-User

Exhibit 3.14 – Information Flow Analysis (Control Elements)

ITS APPLICATION	LOCATION	POTENTIAL SYSTEM USERS																				
		Caltrans D5	CHP	MPOs/RTPAs	City/County Traffic Eng.	City/County Planning	City/County Law Enforcement	Transit Providers (Public Agency)	Transit Providers (Private Sector)	Rail Organizations (Public Agency)	Rail Organizations (Private Sector)	EMS Providers	CVO Carriers	ISPs/Media	AQMD/APCD	Tourism Boards	Towing Services	Rental Car Companies	Activity Centers/Special Events	Parking Facilities	CA Office of Motor Carriers	Travelers
Transportation Management Centers (TMCs)																						
	Region-wide	PC	PC	SS	PS	SS	PS	PS	EU	EU	EU	PS	EU	PS	SS	SS	X	EU	SS	SS	SS	EU
	City/County	SC	PC	SS	PC	SS	SC	PS	EU	EU	EU	PS	EU	PS	SS	SS	X	EU	PS	PS		EU
	Agency-specific	PC	PC	SS	PC	SS	PC	PC	EU	EU	EU	PS	EU	PS	SS	SS	X	EU	PS	PS		EU
Ramp Meters																						
	State roadways	PC	SC	SS	PS	SS	PS	SS	EU			SS	EU	PS	SS			EU	SS	SS		EU
Traffic Signals																						
	State roadways	PC	PS	SS	SC	SS	SS	SS	EU	EU	EU	SS	EU	PS	SS			EU	SS	SS		EU
	Local arterials	SC	SS	SS	PC	SS	PS	SS	EU	EU	EU	SS	EU	PS	SS			EU	SS	SS		EU
Freeway/Arterial Coordination																						
	Corridor-specific	PC	SC	SS	PC	SS	PS	SS	EU			SS	EU	PS				EU	SS	SS		EU
Road Weather Information Systems (RWIS)																						
	State roadways	PC	PS	SS	PS	SS	SS	EU	EU	EU	EU	EU	EU	SS				EU				EU
	Local arterials	PS	SS	SS	PC	SS	PS	EU	EU	EU	EU	EU	EU	SS				EU				EU
Speed Warning System (Curve/Grade)																						
	State roadways	PC	PS	SS	PS	SS	SS	EU	EU			EU	EU	SS				EU				EU
	Local arterials	PS	SS	SS	PC	SS	PS	EU	EU			EU	EU	SS				EU				EU
CAD System																						
	Region-wide	PS	PC		PS		SC	PS		EU		PS		SS			X					
	Agency-specific	PC	PC		PC		PC	PC	PC	PC	PC	PC	PC	SS			PC	PC	SS			
IM Response Plans																						
	Region-wide	PC	PC	SS	SC	SS	SC	PS	EU	EU	EU	PS	EU	PS		X	X	EU	SS	SS		EU
	State roadways	PC	PC	SS	SC	SS	SC	PS	EU	EU	EU	PS	EU	PS		X	X	EU	PS	SS		EU
	Local arterials	SC	PC	SS	PC	SS	PC	PS	EU	EU	EU	PS	EU	PS		X	X	EU	PS	SS		EU
Signal Priority																						
	State roadways	PC	EU	SS	SC	SS		PC				PC		SS								
	Local arterials	SC	EU	SS	PC	SS		PC				PC		SS								
Highway/Rail Intersections (HRI)																						
	State roadways	PC	PC	SS	SC	SS	SS	PS	EU	PC	PC	PS	EU	PS				EU				EU
	Local arterials	SC	SC	SS	PC	SS	PS	PS	EU	PC	PC	PS	EU	PS				EU				EU
CVO Electronic Clearance [Includes --> Weigh-in-Motion (WIMs), Administrative Processing, Roadside Safety Systems, etc]																						
	Region-wide	SS	PC	SS		SS	PS						PS								SC	
	State roadways	SS	PC	SS		SS	PS						PS								SC	
	Local arterials	SS	PC	SS	PS	SS	PC						PS								PS	

NOTES:

1) There exists the need and/or potential for data/information sharing with other Caltrans' Districts (as appropriate)
2) For "State Roadways", Caltrans is assumed to "own" the data/information and "shares" with other agencies per MOUs
3) For "Local Arterials", individual agencies are assumed to "own" the data/information and "share" with other agencies per MOUs
4) Data/information is assumed to be in "raw" form for the owning agency and "smoothed" when distributed to a sharing agency or travelers
5) Specific/directional information flows will be depicted within subsequent Data Flow Diagrams (DFDs)
6) The "Traveler" column is considered to be the motoring public
7) Information flow analysis assumes the use of dedicated agency workstations and an integrated communications network throughout the Central Coast

LEGEND:

PC --> Primary Control
SC --> Secondary Control
PS --> Primary Share
SS --> Secondary Share
EU --> End-User

Exhibit 3.15 – Information Flow Analysis (Dissemination Outlets)

ITS APPLICATION	LOCATION	POTENTIAL SYSTEM USERS																					
		Caltrans D5	CHP	MPOs/RTPAs	City/County Traffic Eng.	City/County Planning	City/County Law Enforcement	Transit Providers (Public Agency)	Transit Providers (Private Sector)	Rail Organizations (Public Agency)	Rail Organizations (Private Sector)	EMS Providers	CVO Carriers	ISPs/Media	AQMD/APCD	Tourism Boards	Towing Services	Rental Car Companies	Activity Centers/Special Events	Parking Facilities	CA Office of Motor Carriers	Travelers
CMS (permanent & portable)																						
	State roadways	PC	SC	SS	SC		PS	SS	EU	SS	EU	SS	EU	PS		EU	SS	EU	SS	EU		EU
	Local arterials	SC	SC	SS	PC		SC	SS	EU	SS	EU	SS	EU	PS		EU	SS	EU	SS	EU		EU
	Special events/activity centers	SC	SC	SS	SC		SC	SS	EU	SS	EU	SS	EU	PS		EU	SS	EU	PC	EU		EU
HAR (permanent & portable)																						
	State roadways	PC	SC	SS	SC		PS	SS	EU	SS	EU	SS	EU	PS		EU	SS	EU	SS	EU		EU
	Local arterials	SC	SC	SS	PC		SC	SS	EU	SS	EU	SS	EU	PS		EU	SS	EU	SS	EU		EU
	Special events/activity centers	SC	SC	SS	SC		SC	SS	EU	SS	EU	SS	EU	PS		EU	SS	EU	PC	EU		EU
Internet																						
	Region-wide	PC	PC	SS	PS	SS	SS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	SS	EU		EU
	County-specific	SC	PC	SS	PC	SS	PS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	SS	EU		EU
	Agency-specific	PC	PC	SS	PC	SS	PC	PC	PC	PC	PC	SS	EU	PC		EU	EU	EU	EU	EU		EU
Kiosks																						
	Region-wide	PC	SS	SS	PS	SS	SS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	SS	EU		EU
	County-specific	SC	SS	SS	PC	SS	PS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	SS	EU		EU
	Agency-specific	PC	PC	SS	PC	SS	PC	PC	PC	PC	PC	SS	EU	PC		EU	EU	EU	EU	EU		
Pager Systems																						
	Region-wide	PS	SS	SS	SS	SS	SS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	EU	EU		EU
	County-specific	PS	SS	SS	PS	SS	PS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	EU	EU		EU
Radio-Based Systems																						
	Region-wide	PS	SS	SS	SS	SS	SS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	EU	EU		EU
	County-specific	PS	SS	SS	PS	SS	PS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	EU	EU		EU
Telephone-Based System																						
	Region-wide	PS	PS	SS	SS	SS	SS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	EU	EU		EU
	County-specific	PS	PS	SS	PS	SS	PS	SS	EU	SS	EU	SS	EU	PC		EU	SS	EU	EU	EU		EU
	Agency-specific	PC	PC	SS	PC	SS	PC	PC	PC	PC	PC	SS	EU	PC		EU	EU	EU	EU	EU		EU

NOTES:

1) There exists the need and/or potential for data/information sharing with other Caltrans' Districts (as appropriate)
2) For "State Roadways", Caltrans is assumed to "own" the data/information and "shares" with other agencies per MOUs
3) For "Local Arterials", individual agencies are assumed to "own" the data/information and "share" with other agencies per MOUs
4) Data/information is assumed to be in "raw" form for the owning agency and "smoothed" when distributed to a sharing agency or travelers
5) Specific/directional information flows will be depicted within subsequent Data Flow Diagrams (DFDs)
6) The "Traveler" column is considered to be the motoring public
7) Information flow analysis assumes the use of dedicated agency workstations and an integrated communications network throughout the Central Coast

LEGEND:

PC --> Primary Control
SC --> Secondary Control
PS --> Primary Share
SS --> Secondary Share
EU --> End-User

Central Coast Review

1. Review Physical Architecture connections (Volume II - Section 3.6)
2. Review TMC Guiding Principles (Volume I - Section 3.4)
3. Document specific Agency connections in relation to Information Flow Analysis

Turbo Architecture

1. Input Agency subsystem components
2. Input desired interconnects between Agency subsystem components based on
    - Information Flow Analysis
    - Central Coast Review

3.8 ARCHITECTURE FLOW DIAGRAMS

3.8.1 What Are They?

Basically, architecture flows are the primary data/information flows that can exist between subsystems that make-up a Market Package. Because of this, they are arguably the key tools to show conformance with the National ITS Architecture. This is because architecture flows both cut across and provide the common element to the main components of the National ITS Architecture: functional (Market Packages), physical (subsystems), and organizational (specific Agency-owned subsystems). Through architecture flows, you have a common denominator from which to compare/tailor functionality, system/projects to install, and people/Agencies to talk to.

3.8.2 Why Are They Useful?

The Architecture Flow diagrams are useful to the Central Coast's stakeholders for the following reasons:

- Identifies what data/information flows exist between subsystems
- Establishes the initial data flows from which more detailed ITS project designs can be based
- Provides key materials/diagrams to establish conformance with the National ITS Architecture

3.8.3 What Do They Look Like?

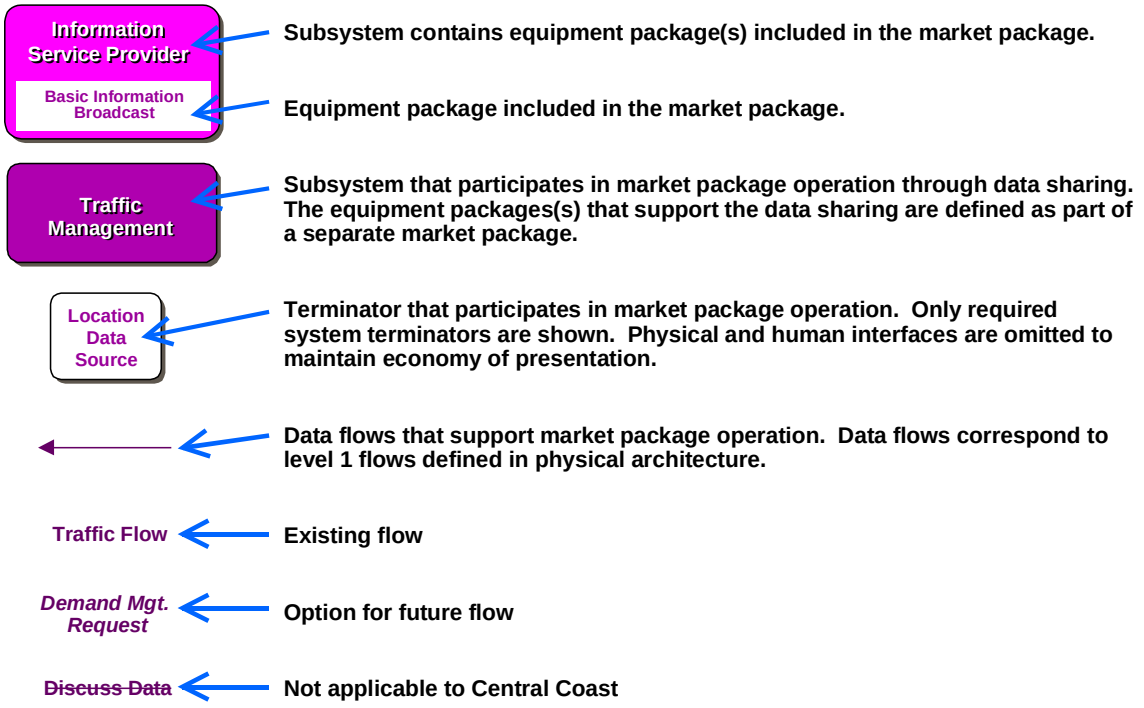
Exhibit 3.16 provides a brief key or legend to better understand all of the pieces that make up the Market Package, and specifically the tailoring approach that was used in the Central Coast. Exhibit 3.17 provides a representative example of the architecture flows that comprise the Incident Management Market Package (ATMS08). As can be seen, the architecture flows have been tailored to reflect existing, future option, and not applicable flows. The full suite of tailored architecture flow diagrams for every Market Package selected for the Central Coast can be found in the appropriate Appendix section (Volume II).

The steps that follow focus on graphically depicting the primary data/information flows that will exist in the Central Coast.

1. Identify all of the Market Packages selected for inclusion in the Central Coast
2. Generate a complete graphical diagram of the entire Market Package (as found in the National ITS Architecture)
3. Develop a set of criteria from which to tailor the architecture flows to the Central Coast
    - Existing flow
    - Option for future flow
    - Not applicable to Central Coast
    - New flow
4. Analyze the Market Package architecture flows
5. Develop tailored architecture flow diagrams for each Market Package according to criteria (found in Step # 3)
    - One (1) full set for each County jurisdictional view
    - One (1) full set for AMBAG jurisdictional view
    - One (1) full set for Central Coast regional view

Please note that some of the architecture flow diagrams may not need to be tailored to the Central Coast views identified in Step # 5 (i.e., they are fine as found in the National ITS Architecture). That's OK. Sometimes, to realize the full benefit and/or functionality that a Market Package has to offer, it needs to be implemented as-is.

Exhibit 3.16 – Architecture Flow Diagram Key/Legend

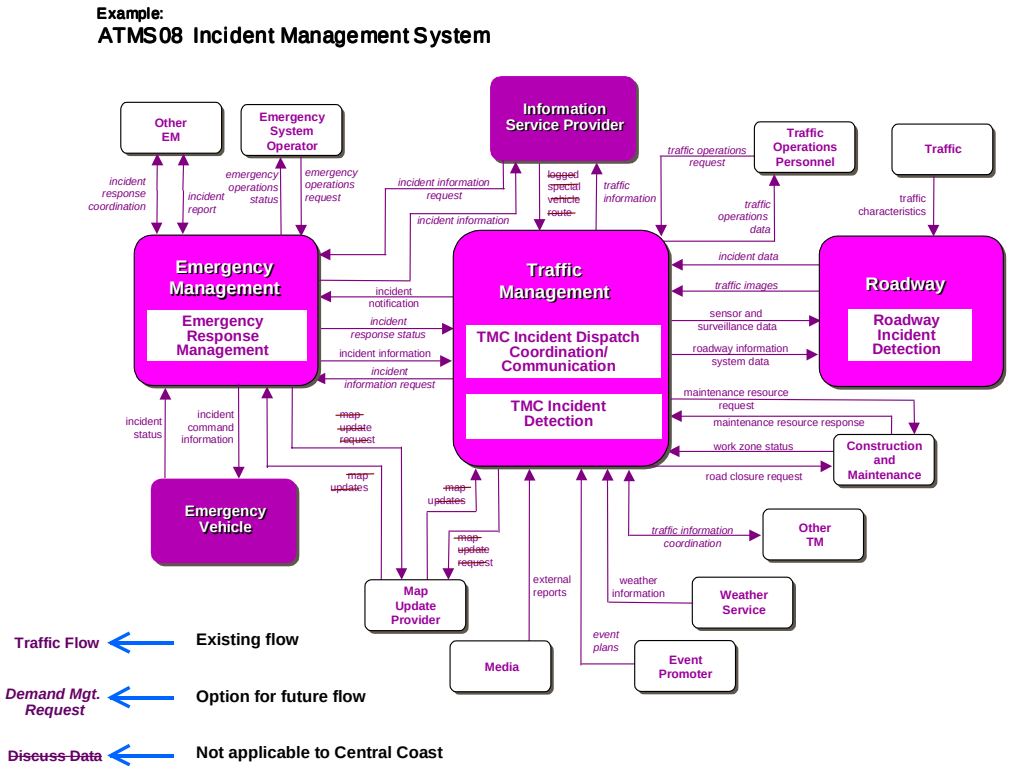


3.9 SPECIFIC CONSIDERATIONS THAT IMPACT THE CENTRAL COAST ARCHITECTURE

Basically, the Central Coast Regional ITS Architecture has been developed for the five-county geographical area based on the needs of the stakeholders. This Regional Framework (and supporting diagrams) have been developed by taking county, inter-county, and regional perspectives into account. However, there are other projects and other Regional ITS Architectures that may have an impact on the Central Coast. These include the following:

- Los Angles/Ventura Region ITS Strategic Deployment Plan (SDP)
- San Joaquin Valley ITS SDP
- San Francisco Bay Area ITS SDP
- CAATS Statewide ITS Architecture
- Caltrans/CHP TMC Master Plan

Exhibit 3.17 – Representative Architecture Flow Diagram



Basically, the Central Coast Regional ITS Architecture will need to be analyzed when inter-regional activities, operations, information sharing, etc. are contemplated. This means that current Regional ITS Architectures for all involved partners will need to be investigated to ensure that the proposed activities, information sharing, etc. can be accommodated/supported. If not, then the Regional ITS Architectures need to be revised to reflect the desired level of integration.

3.10 CENTRAL COAST CONFORMANCE TO THE NATIONAL ITS ARCHITECTURE

3.10.1 Planning Conformance

As described previously, the ITS Strategic Plan for the Central Coast contains a Regional ITS Architecture that is in conformance with the National ITS Architecture. We can say this because the Central Coast took into account those same elements that the Architecture is looking for to determine planning conformance as shown in Exhibit 3.18:

Exhibit 3.18 - Planning Conformance in the Central Coast

Conformance Requirement	Central Coast Approach

1. Participation by a broad range of stakeholders	▪ Steering Committee participants
	  ▪ Five (5) Central Coast counties
	  ▪ FHWA
	  ▪ Caltrans (D5 & NTRP)
	  ▪ CHP
	▪ Outreach & consensus building efforts to local agencies and private sector firms (Project Task 1 and throughout project duration)
	▪ Use of existing Agency channels to put ITS on the agenda

2. Identification of how local needs can be addressed by ITS	▪ User needs definition (Project Task 2) ▪ ITS opportunities (Project Task 3) ▪ User Services & ITS Vision (Project Task 4) ▪ Market Package selection (Volume I - Section 3)
3. Description of existing & planned ITS enhancements including: ▪ Physical inventory ▪ Sharing of information	▪ Existing system inventory (Project Task 2) ▪ Define ITS Project Ideas (Volume I - Section 3) ▪ "Mapping" existing & planned systems to the Physical Architecture (Volume II - Section 3) ▪ Define the Organizational Architecture (Volume II - Section 3)
4. Definition of a Regional ITS Architecture ▪ Subsystems ▪ Architecture flows	▪ Tailored "sausage" diagrams as the Physical Architecture (Volume II - Section 3) ▪ Tailored architecture flow diagrams from selected Market Packages (Volume II - Section 3)
5. General concept-of-operations	▪ Market Package selection (Volume I - Section 3) ▪ ITS project descriptions (Volume I - Appendix E)
6. Roles & responsibilities for stakeholders	▪ ITS project descriptions (Volume I - Appendix E) ▪ Implementation Guidance (Volume II) ▪ "How-to" use the Architecture (Volume II - Section 3)
7. Phasing considerations ▪ Geographical ▪ Functional	▪ ITS project descriptions (Volume I - Appendix E)

The question on conformance with the National ITS Architecture will arise at the point where federal funds are requested for a specific project. At the time of printing of this document, the US DOT is considering publication of proposed regulations on the National ITS Architecture and Standards through a Notice of Proposed Rule Making (NPRM) in the Federal Register. At the completion of that Federal Register process, the FHWA and FTA will provide guidelines for the

conformance process and exact set of information required. In general, by conformance with the National ITS Architecture we mean that an ITS project supports the subsystems which define it in the following manner:

- Supports some subset of the functions defined for that subsystem (i.e., entire and/or tailored Market Packages mapped to subsystems)
- Rationale has been provided for any functions that have been excluded (i.e., selected Market Packages traced to user needs)
- Allocates the proper functions to the proper subsystems (i.e., entire and/or tailored Market Packages mapped to subsystems)
- Supports the data flows relevant to the included functions for that subsystem (i.e., tailored architecture flow diagrams)
- Uses open system interface standards (where applicable)

Although all of the Architecture conformance points listed in Exhibit 3.18 are important, the principal test to determine if an ITS Project (either included herein or future) is in conformance with the Central Coast Regional ITS Architecture (and thereby with the National ITS Architecture) is explicitly addressed in Item #4. To that end, the ITS Project in question needs to be identified as to its specific place in the Regional ITS Architecture (subsystem and architecture flow).

At this time, a number of items concerning conformance with the National ITS Architecture are not complete. These include the following:

- Federal Register process for Architecture conformance
- Guidelines for following this conformance process
- Exact set of information required in the conformance process
- Determination of which Agency (ies) are responsible for Architecture conformance

Despite the lack of finality that exists within the Architecture conformance process at this time, Agencies in the Central Coast have requested that some preliminary guidance be developed that would provide them with a flavor of what they should expect in the near future as it concerns Architecture conformance. The following sections provide this preliminary guidance. Please note that the steps and/or responsibilities outlined in the following sections are not final: only the FHWA and FTA can provide this information.

3.10.2 Physical Architecture Conformance

To minimize problems that could be associated with this conformance determination, the following preliminary guidelines should be considered:

1. Review ITS Project Description (please refer to Volume II - Section 2.1)
2. Determine appropriate Market Package association
3. For specific association, analyze Market Package subsystems and interconnects
4. Determine if there is a subsystem or interconnect reference that matches the Physical Architecture (sausage diagram) for your specific County
5. If there is a match, the subsystem or interconnect remains on the diagram
    - Add/list the individual Market Package to the side of each related subsystem by:
        - National ITS Architecture name
        - National ITS Architecture coding shorthand
    - Below each Market Package, list the ITS Project
    - Tailor system or interconnect into local or regional reference
6. If no match, add subsystem or interconnect to specific County diagram
    - Add/list the individual Market Package to the side of each related subsystem by:
        - National ITS Architecture name
        - National ITS Architecture coding shorthand
    - Below each Market Package, list the ITS Project
    - Tailor system or interconnect into local or regional reference
7. Work with ITS Coordinating Group (please refer to Volume II - Section 1.1) to determine if any new subsystem or interconnect references should expand beyond specific County
    - RTPA level
    - Regional level

3.10.3 Architecture Flow Conformance

To minimize problems that could be associated with this conformance determination, the following preliminary guidelines should be considered:

1. Review ITS Project Description (please refer to Section 2.1)
2. Determine appropriate Market Package association
3. For specific association, analyze Market Package architecture flows
4. Determine if the architecture flows for the specific County include the appropriate type of flows to deploy ITS Project:
    - Existing flow
    - Option for future flow
    - Not applicable to County
5. If the architecture flows are appropriate, go to Step #7
6. If the architecture flows are not appropriate, tailor the architecture flow diagrams for that Market Package
    - Existing flow
    - Option for future flow
    - Not applicable to County
    - New flow
7. Work with ITS Coordinating Group (please refer to Volume II - Section 1.1) to determine if any modifications to the architecture flow diagram should expand beyond specific County
    - RTPA level
    - Regional level

3.10.4 Responsibility for Conformance

At this point, a general process for ensuring that ITS projects in the Central Coast are in conformance with the National ITS Architecture, as required in Section 5206(e) of TEA-21, has been provided. FHWA and/or FTA will determine whether a project is in conformance when the application is made for the use of federal funds. To minimize problems that could be associated with this conformance determination, the following preliminary guidelines should be considered:

1. FHWA/FTA will provide a determination of the conformance of the Central Coast Regional ITS Architecture with the National ITS Architecture.
2. The organization approving the TIP should make the determination of conformance locally.
3. Information on conformance with the Central Coast Regional ITS Architecture should be included in the project submission by the sponsoring agency when the project is submitted to the TIP. This should include at least the following information in addition to the normal information on project description, location, funding sources, etc.:
    - Identification of where the project fits within the regional architecture diagrams in the ITS Strategic Plan (see appropriate Appendix sections in Volume II)
    - Other projects with which the project will be designed to exchange information
    - Other agencies with which coordination has taken place or will take place as the project is implemented
    - A commitment to design to applicable national ITS standards
    - A statement as to whom is responsible for operations and maintenance and how operations and maintenance funds are being secured

4. WHAT AGENCIES SHOULD KNOW ABOUT SELECTING TECHNOLOGIES

Doing projects that involve state-of-the-art technology can be rewarding and enjoyable, at least in the initial stages. There are some things that agency staff can do to keep the project successful and fun through the life of the project, and not just for the first month. The key questions posed hereafter are intended to highlight some common problems found in high technology projects.

4.1 TECHNOLOGY PUSH VERSUS MARKET PULL

New technologies arrive literally every day. Since ITS is itself an emerging industry, it is especially blessed with new companies, new ideas, new technologies and new approaches. All have in common the use of a new technology to solve an old problem.

Early in the life of technologies, the champions of the technology itself push for it to be used in real world projects. It is seldom ready for widespread use right away. Later in the life of the technology, when enough market penetration has been made, the market itself will pull the technology along in synergistic fashion. You want to select technologies that are being supported by key sectors of the market. This means not only that they are being bought, but also that other complementary products or services are available in the market.

Here are a few key questions you should ask:

1. Am I the first one to actually use this device or concept in the real world?
2. Has this version of the product been offered in the market for at least six months?

3. Will our requirements remain stable over the probable life of the technology? If not, for about how long?
4. Am I willing to stake my professional reputation on this technology?
5. Am I trying to solve a political problem with a technological solution?
6. What critical components of the approach are real versus merely marketing material?
7. Am I being asked to invest in tools to create the components of a system, rather than an operating system?

4.2 STRENGTH AND STABILITY OF THE VENDOR

Buying into a particular technology often means buying into the particular vendor that developed it. It is the nature of things that companies come and go, but some foresight can assist the agency in avoiding obvious problems. This Strategic Plan is about implementation and deployment of ITS technologies to benefit the public, not about research and development of those technologies. Make your investment accordingly. A level of comfort must exist with the company and the individuals with whom you are dealing or the relationship will be rocky throughout the project.

Key Questions:

1. Have I run a Dun and Bradstreet or equivalent check on the financial health of this vendor?
2. How long has this company been in business of producing or selling this particular technology?
3. Am I willing to stake my job on this vendor's performance?

4.3 FORMAL RISK MANAGEMENT IN YOUR PROJECT

Many agencies have risk management staff. These individuals are concerned with the management of financial risk due to such things as liability. This section is not about managing exposure to lawsuits, but rather about managing the risk that your project will fail to meet the requirements.

This happens more often in public agencies than most agency staff would care to think. Some studies show that more than 40% of computer projects fail to meet major requirements. You can apply lessons learned in other similar projects to identify likely areas where trouble can arise, and make some estimate of the probability of occurrence. You can rate these as low, moderate and high, rather than trying to assign a numerical score or probability. It is enough to know that the risk is high, without doing an analysis

A typical initial risk analysis will probably identify four areas of risk to your project: selection, management, technology, and political.

In many cases, your potential project must compete for funds with other projects. Selection risk is associated with the selection process, and thus gaining the required funding. Competition could be at the Federal or State level. If not described and targeted properly, your application for funds has a much lower chance of selection. To reduce this risk, you must:

- Assemble a competent project team
- Develop a concept that directly coincides with the fund source mission and program
- Seek and receive significant local matching funds to prove the interest and worth of your project
- Write a good proposal to communicate this to the selection authority

Management risk includes risk factors in process, resources, cost and schedule. The simplest approach to process risk is to adhere to formal procedures. If your agency does not have them, consider borrowing or developing a tailored set of processes and procedures to be followed. ITS often introduces new challenges in the process of contracting for, purchasing, and maintaining equipment and software.

Risk associated with resources always goes back to under-capitalization of the project in people, funds, or other critical factors. Your project should be part of your agency's on-going program, and should be designated to receive full agency support, including that of your board or council. ITS is often not understood by elected official, because it is a non-traditional way of approaching transportation. New board or council members may need to be briefed. This is where easily read written material or a video explaining the effort is helpful.

Risk due to cost growth (running over budget) must be tracked throughout the project. One recommended procedure is to prepare a new Estimate to Complete for your project after any major unexpected event.

Risk due to schedule is best minimized in the development of the initial project schedule. In addition to the normal timelines associated with implementing technology projects, consideration must be given to applying agency milestones and board meeting milestones. Actions requiring formal board approvals don't always pass the first time around, and such delays must be planned for.

Technology risk is associated with development of the individual pieces of the system, and their successful integration. We recommend using "best available with track record" hardware and

software components. By track record, we refer to items that have at least six (6) months of use as products in a field environment (not at the beta or prototype level), so we can get data on actual field performance, including reliability and maintainability. This conservative approach selects the best possible technology, and avoids the situation of being the first trial of new products, with all the difficulty usually experienced in that position. This approach should help to hold technology risk at a low to moderate level. Progress on installation and integration should be discussed each week during the project conference.

Political risk involves maintenance of a stable political outlook for program success. Administrations change, and continuing education is often needed to provide reassurances that the project is a good investment. Constant attention must be paid to the politics of your project, because questions can arise very quickly, unexpectedly and from unexpected sources. While it is not possible to quantify this risk, close and continuing work will act to mitigate situations as they arise.

Key Questions:

1. How well does the risk management philosophy of this vendor match the culture of this agency?
2. Does the vendor have a formal engineering quality methodology such as the ISO 9000 standards?

5. CONTRACTING AND PURCHASING

5.1 PROCUREMENT METHODS

Intelligent Transportation Systems are, by their very nature, multiple agency and multiple jurisdiction projects. Frequently the individual agencies involved do not have the resources to design and install them. Most often one of the agencies, acting for the multiple agencies, contracts with private industry for design, installation, or both. The lead agency for contracting is usually the one whose contracting rules are the easiest or quickest to navigate. Delays in purchasing equipment or services for the project because of slow or complex procedures and approvals may well cause projects to miss deadlines for project implementation imposed by the funding source.

5.1.1 Sole Source

Because of past abuses and legislative reaction, public agencies do not favor sole source contracts. This form of procurement is most often used when there is a documented existence of one technical solution to the project requirements, or when compatibility with an existing base of equipment or systems is required. Prior approval to use the sole source is normally required from the agency's Board.

Because ITS projects require compatibility across a region, which may be much larger than a single agency's area of operation, sole source contracts or *de facto* sole source contracting may be required and justified.

5.1.2 Competitive Procurements

Competitive procurements allow the public agency to select from an array of technical approaches, schedules and costs, and to promote fairness in public contracting. The most

common competitive procurement methods used for ITS projects are described below. Ongoing changes to these procedures should be expected, given the differences in procedure amongst agencies involved in ITS projects, and those likely to come from the reauthorization of the ITS program in moving from ISTEA to TEA-21.

5.1.3 State of California Competitive Bidding Procedures

The State of California has evolved a set of competitive bidding procedures that are also available for local agency use.

Exhibit 5.1 - State of California Competitive Bidding Process

Background	The State of California primarily procures goods and services through competitive bidding.
Definition	Competitive bidding means the process of obtaining bids in such a manner as not to limit bidding directly or indirectly to any one bidder, and to award the contract to a responsive and responsible entity offering the lowest price, or the most cost effective solution.
Bid/Proposal Review and Evaluation	Bid/proposal review and evaluation involves applying the three R's: Is the bidder responsive, responsible and reasonable? A bidder must meet all three R's to be successful. The following definitions explain the distinctive meaning of each. **Responsive:** meeting deadlines, specifications and compliance, signing and returning all necessary forms, including required licenses and documents **Responsible:** availability of parts and services, past record with the State **Reasonable:** lowest price, the optimum solution at the optimum cost to the State, feasibility
Solicitation Methods	The following chart offers comparison of the types of methods in competitive bidding.

Exhibit 5.2 - Types of Competitive Bidding Methods

Method	Definition	Review Method	Award Method
Invitation for Bid (IFB)	"Here is exactly what we want, how much will you charge us?"	After bid opening, review low bid to ensure that it is responsive, responsible, and reasonable.	Award to the lowest responsive and responsible bidder.
Request for Proposal (RFP)	"Here is what we wish to accomplish, how would you accomplish it for us and for how much?"	**Primary** Technical proposals reviewed and points are assigned. Those who meet qualifications are placed in a pool from which the lowest cost bid is selected. **Secondary** Evaluation committee assigns points to proposals that are responsive, responsible, and reasonable	Award to the lowest responsive and responsible bidder. Award to the highest scored proposal.
Request for Qualifications (RFQ) (Architectural and Engineering)	"Here are our selection criteria for providing the service, how does your experience fulfill the criteria requirements?"	Responses are evaluated to determine most qualified, then negotiate to reach the best qualified at optimum cost to the State.	Award to the best qualified with the optimum cost to the State.

Source: California State Contracts Register February 10, 1995

5.1.4 Two-step Process for Engineer/Contractor or Turn-key Engineer/Contractor

This procurement approach has traditionally been used by transportation agencies for civil engineering contracts. Typically, an engineer prepares a single set of contract documents (Plans, Specifications and Estimates PS&E) for a specific phase of the proposed system. For an ITS project such as those found in this plan, a specialty design consultant is often used when public agencies lack the ability to do so.

The completed contract documents are then advertised, bids are received from contractors, and the project is awarded to the lowest or best value responsible bidder. The winning contractor is responsible for providing a complete and full operational system, including furnishing and installing all hardware and software, system integration efforts, training and documentation, and the development of operational concepts and plans.

If the process forces a break for further competition between the phases, it is called two-step, otherwise, it is called turn-key in recognition that the public agency will receive a system ready to "turn the key" and go operational.

The consulting engineer often continues activities during system installation by monitoring the contractor's progress, reviewing contractor submissions, participating in the system testing, providing interpretations of plans and specifications, and developing data bases and operational plans if not done by the contractor. The consultant may also provide training.

Generally there will be one contract to prepare and administer for each construction phase; however, no single prime may possess the necessary experience and qualifications to perform all of the work included. Therefore, the prime contractor can be expected to use subcontractors and perhaps tiers of subcontractors, depending upon the breadth and complexity of the work.

The prime contractor is the contractually responsible entity for the prime's staff, the subcontractors and equipment suppliers. The prime contractor must coordinate and manage the subcontractors, a critical issue for project success. Administering multiple layers of subcontractors and suppliers is difficult even under the best conditions. It requires good human relations, technical expertise in the subject mater, and familiarity with the type of work being performed by the subcontractors.

In the engineer/contractor approach, the administering agency generally retains the responsibility for ensuring conformance with bid documents and for testing and accepting system elements. The agency is also generally responsible for coordination between contractors working on the various phases of the overall program.

5.1.5 Design/Build

In the design/build approach a single responsible entity is selected to perform all work associated with deployment of the system. The public agency's sole role is monitoring the activity of the designer/builder. The designer/builder performs all design work, contracts for or constructs system elements, commissions the system and turns it over to the operating agency.

In the United States, the design/build approach has most often been used for buildings and for Department of Defense procurements. Design/build is used extensively for transportation projects outside the United States. The design/build process is the least well known in transportation projects, and procedures are not well established. In the US one or more firms develop a conceptual plan for the project, and the "best" concept is selected. The firm then carries the design through preliminary engineering and design, sometimes called the "30% design level". Negotiations are then held for the final cost of implementation.

After the agreement is negotiated, the designer/builder completes all aspects of the project in conformance with the preliminary design. A key attribute of the design/build approach is the

complete transfer of responsibility for completion to the designer/builder. This generally allows the project to be completed more quickly, as procurement procedures can be streamlined and problems can be resolved quickly. The designer/builder is under significant incentive to reduce its costs and risks. This leads the design/builder to complete all work quickly and turn the system over to the agency.

The agency role is to supervise the designer/builder to ensure that quality is maintained, and that the designer/builder meets the schedule. The design/build approach can present some difficulty in coordinating technology changes. The public agency also may have to make decisions more quickly than their traditional decision loop can easily handle.

5.1.6 System Manager

The system manager approach uses a single entity in charge, known as the system manager. The system manager may be a specially staffed and equipped office of the public agency. More likely, it is a private sector consultant. The system manager is typically responsible for preliminary design and program definition, preparation of standard bid documents, preparation of final bid documents or supervision of others performing these services, development of any required software, procurement of software or hardware, system integration, preparation of concept of operations and operation plans, and training and documentation. Overall system management and quality control of other consultants or contractors is also typically provided. The contract between the agency and the system manager is expected to be a negotiated agreement for engineering services similar to design contracts. Both parties jointly determine the scope of work, define their respective duties and responsibilities, develop a realistic estimate of the corresponding costs, and fully define what is required from the system before the work actually commences.

Instead of a single construction contract, several contracts for the various subsystems are prepared. The agency's normal procurement processes are generally used to procure the individual subsystems and services; however, the system manager may administer these contracts and is responsible for integrating the various subsystems into an operating system. The system manager also controls technical specifications and standards throughout the construction phase, even where others do design work.

An inherent feature of the system management approach is the overall system design, and required hardware and software development, and system integration and testing activities are all controlled by a single entity — the system manager. The approach provides continuity through the process as well as a single focus of responsibility and accountability.

5.2 EVENTS IN PROCUREMENT POLICY

The Professional Engineers in California Government, an organization largely representing Caltrans engineers and technical staff members, has qualified an initiative for the next statewide ballot. If the initiative passes, it will require that engineering services for state projects be done by state employees.

SB 45 (signed by the governor in October, 1997) makes significant changes to the State Transportation Improvement Program development process. Funding sources have been collapsed into two programs. Clean-up legislation is to follow, and all agencies are working together on the first post-SB 45 STIP. Please contact your local county transportation commission, Caltrans district office or the California Transportation Commission for the latest information on the SB 45 process.

5.3 KEY QUESTIONS

To assist the Central Coast in its ITS procurement and contracting efforts, a few key questions have been prepared:

Procurement Strategies and Contracting Options

1. Are you familiar with procurement methods that may be appropriate to ITS programs?
2. What procurement method will you use that will both ensure the quality of the products and that the supplier will stand behind them?
3. Have you talked with other customers of the vendors you are considering?
4. Have you determined how good their services and follow-through has been?
5. Has this version of the product actually been used with success?
6. Are there provisions in your procurement package to establish a reasonable cost for spare and replacement parts?
7. Will this decision lock you into a single vendor in perpetuity?
8. Do you have provisions for warranties on software?
9. Are software upgrades likely to be necessary and are multiple vendors available to provide those upgrades?
10. Should I be procuring in conjunction with other Agencies to obtain the best possible price?
11. Do your contracts contain clear, concise Terms and Conditions that effectively manage risk?
12. Have you established realistic project costs and secured funding up-front?

13. Have you considered a "best value" approach rather than "low bid"?

14. Have you considered a phased contract approach:

    - 1st phase → cope-out effort, document requirements, sort out institutional policy differences, develop, system design, etc.
    - 2nd phase → project implementation, acceptance testing, training, documentation, etc.

15. Have you considered different contract approaches dependent upon the type of work to be performed (e.g., do not use Fixed Price for undefined software development, use Time and Materials or Costs Plus Fixed Fee for scoping phases, etc.)?

16. Is a process in place to "distribute" contract responsibility to ensure that every Agency has a stake in the final outcome?

17. Have you included documentation and training considerations in the contract?

6. PREPARING FOR DEPLOYMENT: OPERATIONS AND MANAGEMENT

The use of advanced technologies in a formerly lower technology environment requires adjustment in several areas, not the least of which is mindset. The agency will be procuring not only building blocks, but also complex systems, and services for the integration of existing systems with new systems.

6.1 PROGRAMMATIC

It is prudent to begin with a low cost project with low risk. This approach should yield a successful project that can be used as an example of an early ITS success. This is important both to project political sponsors and to the public who are the ultimate users of the system.

A second outcome of the first project will be the identification of institutional issues which must be overcome or dealt with to deploy an ITS project.

6.2 ORGANIZATIONAL

ITS projects include private partners as well as the traditional agencies involved in transportation. Much of the funding involved in ITS deployment over the 20-year planning horizon is assumed in the federal ISTEA I/ISTEA II/TEA21 program and proposals to be from private sources. Getting private, for profit partners involved in ITS is a challenge.

The California Alliance for Advanced Transportation Systems (CAATS) is a public-private partnership to accelerate the deployment of ITS in California through strategic collaborative actions.

The Southern California Partnership, Californians for Better Transportation, and the California Council on Science and Technology are also working to facilitate private involvement in transportation and ITS.

An important function which should be represented in the organizational structure to the agency ITS program is outreach. A successful outreach program will build the public support necessary for continuing funding for ITS projects.

6.3 TECHNOLOGICAL

Technology will be in a state of constant change; this condition must be lived with, and you may even get to the point where you enjoy it. An ancient Chinese curse is “may you live in interesting times”. ITS projects are definitely interesting. One factor that ensures that the project will remain interesting is systems integration.

Systems integration is the engineering art of combining existing components and systems with new components and systems, and ending up with a system larger in scope, higher in complexity, and (hopefully) more capable of meeting requirements. Frequently, software is the glue used to combine the parts. In practice, system integration is like peeling an onion, but an onion with layers of differing thickness, composition and degree of difficulty. This onion is unlike any onion from the garden; it tends to grow in scale as you peel it.

A traditional way to do systems integration is to proceed in a defined series of phases, beginning with a core set of capabilities and proceeding over time to the objective system. Often, annual capability upgrades are planned. Frequently in very complex systems, a prototype system is proposed as a first step. The underlying assumption in prototyping is that the prototype can be scaled up to meet the requirements of the desired system; in practice, this is not always true.

6.4 KEY QUESTIONS

To assist the Central Coast in it ITS O&M efforts, a few key questions have been prepared:

Operations and Management

1. Have all of the O&M considerations been planned for?
2. Are appropriate staff available/trained to "de-bug" and "troubleshoot" software and hardware problems?
3. Have you determined that the system/project will be used on a continuous basis, and not remain idle?
4. Has the project's/system's O&M responsibilities/expectations been tailored to the Agencies' needs and capabilities?

7. STAFF QUALIFICATIONS AND TRAINING

7.1 AGENCY STAFF ACTIVITY BACKGROUND

Transportation agency staffs apply a series of tasks in performing their roles:

- Data collection;
- Information fusion
- Situational assessment
- Application of knowledge; and
- Problem solving.

In particular, when operating in the team environment found in public agencies today, staff planners, designers and operators must do all of the above in a consensus environment. The consensus must be formed not only with the other local agency people, but also with federal, state, regional representatives.

7.2 SUBJECT MATTER EXPERTISE

The idea of a subject matter expert was first conceived in the discipline of artificial intelligence. When people began to build artificially intelligent systems, the first attempt was the expert system. An expert system, in theory, can capture in its software the knowledge of an expert in a subject area, which then will be available for problem solving. The subject matter expert worked with the expert system designer, and perhaps other computer experts, to create an operating expert system. Neither alone could do the whole job, but the team of experts could.

7.2.1 Subject Matter of ITS

ITS projects are inter-disciplinary, in that a wide-ranging collection of knowledge and experience is needed, and no one current technical discipline covers the needs.

7.2.2 Education and Training

How to educate and train the ITS professional is an active research area of ITS AMERICA, the ITS professional society, and the U.S. Department of Transportation in its Professional Capacity Building (PCB) Program. The skills and knowledge required to plan, design, and operate transportation systems and associated technologies are under active consideration.

An approach now being introduced in San Diego involves an inter-disciplinary master's level program at San Diego State University. Students are drawn from the civil engineering department and the electrical engineering department, and complete a series of courses. The graduate is equipped with the basic knowledge of the technology aspects of ITS. Complementing the SDSU program is an ITS technician level program at Miramar College.